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MOLDIR NURSEITOVA

Study of bioaccumulation and detoxification mechanisms of persistent organic pollutants (PCB, DDT) in bodies Bactrian camels

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Research supervisors
Candidate of geographical sciences,
T. Bazarbayeva
PhD S. Jurjanz
PhD B. Faye

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NORMATIVE LINKS

In this dissertation used the references to the following standards:

ST RK 166-97 Camel milk for processing at shubat (Молоко верблюжье для переработки на шубат.).

GOST 23452-79 Milk and milk products. Methods of determination of organochlorine pesticide residues (Молоко и молочные продукты. Методы определения остаточных количеств хлорорганических пестицидов)

MET038 Analyse DES PCB indicateurs

GOST 25101-82 Milk analyzer Laktan 1-4 mini (Анализатор молока «Лактан 1-4») registration № in KZ.02.03.01453-2006/13134-05

GOST 22760-77 Method for determination of fat in the calibration samples of milk (Метод определения жира при градуировке проб молока)

GOST 3626-73 Method for determination of SNF in the calibration samples of milk (Метод определения СОМО при градуировке проб молока)

GOST 3625-84 Method of determining the density of the calibration samples of milk (Метод определения плотности при градуировке проб молока)

GOST 25101-82 Method for determination of the addition of water in the calibration samples of milk (Метод определения добавления воды при градуировке проб молока)

LIST OF ABBREVIATIONS

- ADI - Acceptable Daily Intake
- BW–Body Weight
- COR – Carry over rate
- DDT – Dichlorodiphenyltrichloroethane
- DDE - 1,1-Dichloro-2,2-bis(p-chlorophenyl) ethylene
- DL PCBs – dioxin like polychlorinated biphenyls
- iPCB – indicator Polychlorinated biphenyls
- HCB – Hexachlorobenzene
- FAO - Food and Agriculture Organization of the United Nations
- GC- MS - Gas Chromatography coupled to Mass Spectrometer
- LD50 - Median Lethal Dose
- LOQ - Limit of Quantitation
- MAC - Maximum allowable concentration
- NIS - New of Independent States
- NDL PCBs – non dioxin like Polychlorinated biphenyls
- OAC - Oriented allowable concentration
- OCPs - Organic Chlorine Pesticides
- POPs – Persistent organic pollutants
- PCBs – Polychlorinated biphenyls
- TCD – Trichlordifenil
- TEF - Toxicity equivalency factors
- TEQ - Toxic equivalents
- UNEP - United Nations Environment Programme
- WHO - World Health Organization

INTRODUCTION

General characteristics of the work. Polychlorinated biphenyls (PCBs) are a group of persistent organic pollutants (POPs) of the environment. There are 209 congeners of PCBs with different physical, chemical and biological properties. The most common PCBs in Kazakhstan are tetra-, penta-, hexa- and heptachlorobiphenyls. PCBs are used in power and chemical plants; they are included in transformer and capacitor oils as additives to paints, plastics, rubber, as well as in lubricants and insulating materials. Many of these sources of PCBs are out of service and no longer used in the industry and remain without a corresponding use and a proper disposal. Existing materials and equipment also increase the risk of inadvertent waste pollution on the territory of Kazakhstan.

Pesticide, such 1,1,1-trichloro-2,2-bis (p-chlorophenyl) ethane (DDT) is known as an effective insecticide widely used in agriculture over 80 years of the last century. Like many other chlorine-containing substances DDT exhibits pronounced properties belonging to the group of POPs.

This thesis aims to study the metabolism of Bactrian camels (*Camelus bactrianus*) by oral contamination of PCBs and DDT, fat-soluble compounds. From a physiological point of view it appears as bioaccumulation in fatty tissues. The study of metabolism in Bactrian camels is associated with the characteristic ability to accumulate fat in the specialized areas of the body - the humps. Thus, the biological model *Camelus bactrianus* initially has a special ability to centralize all the fat reserves in the hump, which greatly differs from all the other farm animals.

Significance of the work. Ecological problems in Kazakhstan are appearing for the decades. Nevertheless, studies on POPs has not yet received an adequate attention. It is known that chlorinated compounds (PCBs, DDT) can accumulate in the soil for decades without losing their properties. The continued presence of contaminants in the environment comes into the general circulation, leads to pollution of soil, and therefore to the plants, and then enters the food chain - to animals and then to the human. Prolonged delivery of POPs to humans causes various diseases, reduces fertility for the whole population. Their action can be called as a background factor in public health, as a limiting factor in the adverse conditions for the initiation of chronic diseases or cancer.

In Kazakhstan, PCB-containing equipment is estimated at 980 tons, and the total volume of waste – at 250,000 tons. The monitoring of unintentional contamination of PCBs is being studied from 2004. Information on the potential entrance of PCBs in the food chain has not yet been studied. Numerous studies on DDT contamination revealed that DDT and its derivatives transferred into the food chain up to human. According to the data of WHO in Kazakhstan was forbidden to use DDT. Policies in the Republic of Kazakhstan regulating the use of insecticides are controlled by the "List of permitted pesticides in 2013-2022 years" and shall be updated annually. In 2013 the state approved the list of 560 recites insecticides for the use in agriculture. More than 500 agrochemicals are imported into the territory of Kazakhstan.

Nevertheless, an international practice has shown that there are the ways to prevent this kind of contamination. Research is being conducted to monitor a

decontamination of laboratory animals and small farm animals. Mainly sheep and goats are treated as biological models. The experiment on fatty sheep showed that contamination happened localized. In this regard, a farm animal like a camel is of particular interest because it has more specialized metabolic stock of body fat. The camel's hump can reach up to 90 kg, which differs significantly from the cattle and requires a separate study, since extrapolation may not be applicable for camels.

It should be noted that traditional livestock industry, a camel, is most common in those parts of the country where the heavy industry is being developed (potential source of contamination) and contacted with grazing pastures. Camel breeding in Kazakhstan is a livestock industry with the least attention in the country. Despite this, the number of camels is growing every year. In January 2014 the population of camels was estimated as 162 thousands. National brand - shubat - produced from camel milk is being modernized. More and more traditional farms intensified and reborn to a new level. Therefore, studies on camel products begins to attract a certain economic interest.

Object of the research: Kinetic of PCBs and DDT in *Camelus bactrianus*. Regular samplings of milk, blood and adipose tissue in healthy lactation *Camelus bactrianus* aged 7-14 years were conducted as indicators of metabolism.

Purpose and goals of the research: The purpose is to study the kinetic of bioaccumulation and decontamination of PCBs and DDT in Bactrian camels *Camelus bactrianus*.

To achieve this goal, the study included 3 steps :

- Management of the specified contamination (PCBs and DDT) by the distribution of oral pollutants all along a contamination period associated with a priming dose by injection
- Assessment of the kinetic of bioaccumulation in the main storage organ (hump) and in the bloodstream during the contamination period, and kinetic of the decontamination after stopping contaminant intake
- Assessment of the carry over rate of decontamination by the evaluation of the milk excretion

The scientific novelty of the study. Camels have a special characteristic as a biological model among all farm animals, and in general all mammals. Feature of camels is the ability to survive and adapt to difficult environmental conditions. At our knowledge, there is no reference on the adaptation of camels to polluted areas. The question of the mechanism of bioaccumulation and decontamination of pollutants was studied in different species but never in camel. Yet, camel is a peculiar biological model because his ability to store fat (pollutants like PCBs and DDT are highly lipophilic) in a concentrated place (the humps). So, the scientific novelty of the thesis is the description of the kinetic of PCB and DDT in camels submitted to controlled contamination. The thesis investigates the kinetic of storage after contamination, and the kinetic of decontamination through the fat mobilization and milk excretion. Milk excretion through the fat component is a normal way of decontamination but it was never assessed in this species characterized by a relatively high content of fat in milk.

Metabolic studies of PCBs and DDT in the body of *Camelus bactrianus* allow to understand the adaptive ability of survival in polluted environments. Previously, similar studies were conducted on laboratory animals or on cattle. Physiological characteristics of laboratory animals are considered from the standpoint of comparison with human physiology. Impact of these pollutants helped to get a general idea, as it could affect the humans. Studies on the sheep and goats conducted for control their meat have underlined the potential contamination all along the food chain. So, studies on special biological models as *Camelus bactrianus* allow to better understand the biological intake of pollutants such as PCBs and DDT, and consequently the risks for the consumers. In addition, it is necessary to take into account that in the desert regions the camels are sometimes the only type of livestock; as a result they are the only source of milk, meat and wool for humans.

This work allows us to make a clear distinction in the definition of food safety of products such as camel milk and meat. It is important to know the mechanism of decontamination of major pollutants such as DDT, which still occurs at times exceeding the occupational exposure in the environment. In addition, the study of the mechanism of metabolism have not previously studied as well as dangerous POPs, such as PCBs. The results obtained are involved in the explanation of public health in the industrial areas, and also in our country.

Theoretical and practical significance of the study.

The main theoretical significance of the study is the role of the main fat storage organ (the hump) in the mechanism of adipose storage and lipomobilization in the kinetic of contamination of the camel organism by POPs. The lipid metabolism in camel is obviously close to that of other ruminants, but the presence of the lipid concentration in one organ could have an effect on the kinetic of molecules having a high lipophilic properties.

Practically, the concentration of fat in the hump is linked to a low fat content in muscle and as a consequence by a lower proportion of fat in meat comparatively to the the most of the other farm animals consumed by humans. It could be concluded that the camel meat is probably lower contaminated than other species in polluted areas. Moreover, the assessment of the importance of transfer of POPs into milk is also of quite importance. On average more than 20% of the pollutants are exported in fat milk in goat and cow (with a high variability according to the different type of pollutant). The determination of this proportion in camel is of huge importance in a country where the consumers appreciate to drink fermented camel milk. Moreover, milk from Bactrian is known for his high amount of fat. The assessment of the risk of contamination of milk in polluted regions could be useful for the authorities in charge of the food safety.

So, the results of the study could allow in the future to better assess the risks in the contaminated areas of the country, and help residents in distressed conditions to survive with minimal risk of contamination. The studies allow using a timeline in the calculations and development of regulations for disposal of animals from contaminated sites. Taking into account the ability to accumulate contaminants in camel's hump, the carcass of the animal can be used in the production of meat. However, it is necessary to add, for the development of more detailed standards

necessary to continue the started study and to investigate the metabolism of PCBs and DDT at a deeper level.

The main provisions of the defense:

- Kinetic of PCBs and DDT in the body of Bactrian camels show an important storage of those contaminants in hump The milk excretion contributes to the decontamination of the animals especially during the phase of fat lipomobilization from the hump

- The blood concentration in pollutants is not necessary an indicator of the level of contamination as it is just a transitory flow

- .

Approbation of the thesis. The results of this thesis have been reported in:

- 7th International PCB workshop, (27-31 may 2012, Arcachon, France);

- The International Workshop «Sustainable Management of Toxic Pollutants in Central Asia: Towards a Regional Ecosystem Model for Environmental Security» Program, NATO SfP-983931 Project (Almaty, March 17-19, 2014);

- The International Congress “Dioxin 2014” (Madrid, Spain, 31st August-5th September 2014);

Publications

The results of research work have been published in 10 publications. Including 1 Journal with an impact factor, 1 - in database of Scopus, 3 - in National journals of Committees list and 5 abstracts in Conferences.

The structure of the thesis

The thesis consists of Abbreviations, Introduction, Literature Synthesis, Materials and Methods, Results and Discussion, Conclusion, References, Acknowledgments and Appendixes.

1 LITERATURE SYNTHESIS

1.1 What are Persistent Organic Pollutants (POPs)?

Persistent Organic Pollutants (POPs) – are organic substances that: possess toxic characteristics; are persistent; bioaccumulate; are prone to long-range transboundary atmospheric transport and deposition; and are likely to cause significant adverse human health or environmental effects near to and distant from their sources [1]. According of these properties in 18 May of 2001 the 110 country signed the Stockholm Convention on Conference of United Nation Organization, where the countries agree: to prohibit and out production, use, and release of POPs. The Convention aims to protect human health and the environment from referenced POPs by eliminating and reducing the worldwide production, their use and their emission [2]. The *Stockholm Convention* was adopted at a Conference of Plenipotentiaries on 22 May 2001 in Stockholm, Sweden. The Convention entered into force on 17 May 2004, ninety (90) days after submission of the fiftieth instrument of ratification, acceptance, approval or accession in respect of the Convention.

In May 1995, the United Nations Environment Program Governing Council (GC) decided to begin investigating POPs. Initially, twelve POPs have been recognized as causing adverse effects on humans and the ecosystem and placed in 3 categories, as the 'dirty dozen'[3]: (table 1).

Table 1 - Initial POPs listed under the Stockholm Convention

Categories	The name of contaminants
Pesticides:	aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene;
Industrial chemicals:	hexachlorobenzene, polychlorinated biphenyls (PCBs) ;
By-products:	hexachlorobenzene; polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDF), and PCBs.

After this Convention there are also number of International Conventions dealing with POPs and Pesticides: *Rotterdam Convention* on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. Aim to promote shared responsibilities in relation to importation of hazardous chemicals and contribute safe use. The Convention entered into force on 24 February 2004 [4].

The Basel convention on the control of transboundary movements of hazardous wastes and their disposal aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes. It has 170 Parties and came into force in 1992[5].

Convention on Long-Range Transboundary Air Pollutants (LRTAP), Protocol on Persistent Organic Pollutants (POPs). The aim of this Convention is that Parties shall endeavor to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution. The aim of the protocol on POPs is to control, reduce, or eliminate discharges, emissions, and losses of persistent organic pollutants. The protocol entered into force on 23 October 2003[6].

In Kazakhstan, the Stockholm Convention was signed on May 23 of 2001 year and ratified on June 7, 2007. In 7 November 2007 were inclusion in the list of parties convention and 8 of December 2009 approval of National Implementation Plan about POPs in Kazakhstan [7]. It is mean that the Republic has taken an important step towards integration into the global process of cooperation in the field of human health and the environment from POPs. For the purposes of a preliminary assessment of stockpiles of persistent organic pollutants in 2003-2004 in Kazakhstan was held initial inventory of PCBs. This project was carried out within the framework of the UNDP / GEF "Initial Assistance to the Republic of Kazakhstan in the performance of obligations under the Stockholm Convention on POPs". During this process, the place of the problem of environmental pollution with PCBs was confirmed [8].

In Stockholm Convention description of the characteristics of POPs are based on the main features and chemical - physical properties of these substances. Depending on the structure of the molecule and the nature of the atoms present in the molecule, these physical and chemical properties span a large range of values [2, p 8-9]. The carbon-chlorine bonds in POPs chemical structure is very stable towards hydrolysis and, the greater the number of chlorine substitutions and/or functional groups, the greater the resistance to biological and photolytic degradation [9]. POPs are carbon-based, often halogenated and characterized by low water solubility and high lipid solubility, leading to their bioaccumulation in fatty tissues. They are also semi-volatile, enabling them to move long distances in the atmosphere before deposition occurs [2, p 7]. The persistence of POPs in the environment, explained having long half-lives in soils, sediments, air or biota. For example, in practice a POP could have a half-life of years or decades in soil/sediment and several days in the atmosphere [7, p 88]. According to Ritter (2004) half-life times for chlordane in soil of approximately one year, of dieldrin in temperate soils of approximately 5 years, of endrin in soil may be up to 12 years, depending on local conditions, of Hexachlorobenzene (HCB) estimated in soil from aerobic and anaerobic degradation range from 2.7 to 22.9 years, of heptachlor in temperate soil is up to 2 years, of up to 10 years, of toxaphene in soil of up to 12 years, depending on the soil type and climate, and for DDT and their metabolites about 8 years. And the half-lives for most congeners of PCB ranged from a few years to approximately 20 years [10].

The physical properties of greatest importance are water solubility, vapour pressure, Henry's law constant (H), octanol/water partition coefficient (KOW), and the organic carbon/water partition coefficient (KOC). Persistence in the environment is the other important property of a substance since transport can extend the range of exposure to persistent substances far beyond the immediate area of use and/or release [2, p 14-15].

During the environmental fate POPs can bioaccumulate in animals and human tissues. The bioaccumulation of POPs depends on a complex of chemical, biological and ecological processes in ecosystem [7, p. 83]. As described before the main characteristics of POPs are low-volatile, non-polar, low water solubility and high lipid solubility, which leading to bioaccumulation in fat tissues and bio magnify to food chain [9, p. 2015]. The first effects and the first data according bioaccumulation of POPs were about transfer to bird's [11] and marine animals. After to proven the impact to the human organism, the main POPs chemicals started to forbidden to use and production. After started to prove a negative impact on the environment and on the human organism, banned the use and manufacture of certain chemicals in the list of POPs. A lot of papers about concentration of POPs in human organisms were published [12].

POPs are also semi-volatile, enabling them to move long distances in the atmosphere before deposition occurs [3, p. 5]. They can be transported over long distances and therefore, can be found in high concentrations even far away from their place of emitting, like oceans, deserts, Arctic and Antarctica. For example the DDT and other pesticides had been detected in beluga whale, polar bear, and fish in arctic [12, p. 170]. In other data [11, p. 910] reported that DDT, PCBs, toxaphene, Chlorbenzol had been found in the bodies of Arctic animals. The main way of movement of POPs in the environment from the emitting source actually to deposit sites are by air, by flue gas and dust and move to long distances in the atmosphere.

POPs are extremely toxic chemicals with acute and chronic effects on animals and humans upon exposure. Partly due to their toxicity, these chemicals resist breakdown by the natural processes and as such, remain within the environment for a long duration. As shown in table 2, most POPs persist in the environment for up to 23 years or more. For example, chemical compounds such as DDT, endrin, HBC, mirex, remain toxic and active for approximately 10 to 23 years as in the soil, as in fatty tissue, and other environmental [13].

One of the main characteristics of POPs is likely to cause significant adverse human health or environmental effects near to and distant from their sources. Humans can be exposed to POPs through diet, occupational accidents and the environment (including indoor). Exposure to POPs, either acute or chronic, can be associated with a wide range of adverse health effects, including illness and death [2, p 21]. Laboratory investigations and environmental impact studies in the wild have implicated POPs in endocrine disruption, reproductive and immune dysfunction, neurobehavioural and disorders and cancer. More recently some POPs have also been implicated in reduced immunity in infants and children, and the concomitant increase in infection, also with developmental abnormalities, neurobehavioral impairment and cancer and tumour induction or promotion. Some POPs are also being considered as a potentially important risk factor in the etiology of human breast cancer by some authors [2, p. 30]. According to the literature [13, p. 29] DDT can be the cause adverse health effects as cancer of liver, immune system suppression. The PCBs and HCH can be causes the cancers, mutations, birth defects, fetal and embryo toxicity, nervous disorder, liver diseases and general liver damage.

1.2 Sources, uses of POPs and reduces in environment

The twelve POPs which in the first list of Stockholm Convention, are used in or arise from industry, agriculture and disease vector control; nine are pesticides used on agricultural crops and for public health vector control.

These 12 chemicals, according Stockholm Convention was added in next 3 groups: pesticides, PCBs and dioxins and furans (table 2). *The first group* occur mainly as a powder or crystalline material (chlordane however is a thick liquid), directly applied to an area or property to specifically treat and kill insects as pests in a variety of forms or as a fungicide on seed to prevent rotting prior to germination; *In second group* are the PCBs that are mainly used in the form of mixtures of oils in electrical transformers and power plant, but also in hydraulic couplings. *In third group* relate to the POPs that result mainly from the by-products of manufacturing other chemical compounds, as waste from certain industrial processes and as a dust emission from incineration of other wastes and industrial incinerators. These are the Dioxins (Polychlorinated Dibenzo-p-dioxins – PCDDs), and the Furans (Polychlorodibenzofurans – PCDFs), hereinafter they will be referred to simply as Dioxins and Furans [14].

Table 2 - The uses and half life time of POPs in soil

	Name	Uses	Half life time in soil (year)
1	DDT	Insecticides	10-15
2	Aldrin	Insecticides	-
3	Dieldrin	Insecticides	5
4	Endrin	Insecticide, rodenticide	up to 12
5	Chlordane	Insect and termit control	1
6	Heptachlor	Insect and termit control	up to 12
7	Hexachlorobenzene	Fungicide	2.7-22.9
8	Mirex	Insecticide	Up to 10
9	Toxaphene	Insecticide	3 month to 12
10	PCBs	As dielectrics in transformers and large capacitors, as heat exchange fluids, as paint additives	10 days to 1.5 year
11	Dioxins	By-product	10-12
12	Furans	By-product	10-12

The European Environment Agency considers that most cases, actually of soil contamination arise from the following industries: chemicals, metals, energy, mining, oil, electronics, glass, ceramics, stone, textile, leather, wood, paper, food, trade, and traffic. The main sources of organic pollutants according of classification of McGrath [15] are industrial and natural. POPs originate mainly from uses in industrial processes, waste incineration and agriculture, as pesticides.

By the late 1970 s, the POPs form list “Dirty Dozen” had been either banned or subjected to severe use restrictions in many countries. But, according of persistent properties of POPs we can found it in different environmental matrices up to today.

All of the nine pesticides and PCBs had been either banned or subjected to severe use restrictions in many countries. But, current information indicates that some of these POPs are still in use in parts of the world where they are considered as essential for ensuring public health [16]. In an effort to further reduce their use in these countries, it is important to understand what countries are using these POPs, and how they are applied. It was found that there is considerable information that describes the aggregate volume of POPs produced and used in the world. However, there is very little reliable data about the specific uses in each country [17]. Although this lack of specific data makes it difficult to evaluate the rationale for the continued use of the nine pesticides, the available information still allows one to discuss the use patterns and barriers to adoption of alternatives in a generic fashion.

The results of the action of POPs on non-target species are characterized by side effects. Toxic effects associated with OCPs include cancer, immunosuppression, reproductive disorders, and development in general. Some POPs can cause disorders of the endocrine system and changing the hormonal system [16, p. 81]. As described before, POPs can accumulate in fat tissues, for example, DDT found in milk sample of cows, which fed contaminated feed with DDT.

Given the widespread use of POPs, including pesticides and its accumulation in food may pose a threat to public health, especially to infants’ organism. In this regard, is not permitted in the presence of POPs in food which supply every day. All these effects of POPs have resulted, setting normative standards for their content in natural and food facilities when considering the state of the environment (table 3) [18].

Despite the fact that many of the organochlorine pesticides are banned for use, their storage remained unspent reserves and contaminated environmental material as soil, sediments, plants and accumulated in animal organisms which given to humans via food chain and transport to the long-range distance from emitting sources[19].

In Russia and in NIS countries there is no sanitary – hygienic for each congeners of PCBs. According to the data [30] for individual PCB congeners, there are sanitary standards of absence (table 3). Maximum Allowed Concentrations (MAC) was installed for industrial substances. As a standard mixture Aroclor 1254 was adopted, which takes into account summary toxic effect of all congeners present in the mixture: In air $1 \mu\text{g}/\text{m}^3$, when in air of working place $1 \text{ mg}/\text{m}^3$, Water drinking and cultural purpose $1 \mu\text{g}/\text{L}$, In soil $0.1\text{-}0.06 \text{ mg}/\text{kg}$, In milk $1.5 \text{ mg}/\text{kg}$ and in fish $5 \text{ mg}/\text{kg}$.

In 1992 for risk assessment of PCBs and PCDD/F mixtures purposes, the concept of toxic equivalency (TEQ) was developed to describe the cumulative toxicity of complex mixtures of these compounds [20]. The procedure involves assigning individual toxicity equivalency factors (TEFs) to the PCDD, PCDF, and PCB congeners in terms of their relative toxicity compared to 2,3,7,8-TCDD, which is considered as the reference congener (TEF=1). The toxic equivalency (TEQ) of a mixture is calculated by `multiplying the concentrations of individual congeners by

their respective TEF, and then adding the individual TEQs to obtain a total TEQ concentration for the mixture. The presence of dioxins and dioxin-like PCBs is expressed as toxic equivalents (TEQ) after multiplication of congener-specific concentration levels with toxicity equivalency factors (TEF) developed based on their relative toxicity compared to 2,3,7,8-TCDD. The current European legislation is based on TEFs set by the World Health Organisation (WHO) in 1998 with the results expressed as TEQ_{WHO98}. New TEFs were suggested in 2005 with the results expressed as TEQ_{WHO05} [21].

Table 3 - The doses of Chlorinated organic pesticides in objects of environment

Normative	Organic chlorinated pesticides			
	sum DDT	Sum HCH	Aldrin, Deldrin	Heptachlor
MAC, mg/m ³	In air			
	0.0005	0.003	-	0.0002
MAC, mg/L	In drinking water			
	0.1	0.02	0.002	0.05
MAC, mg/L	Surface water			
	2			
MAC, mg/kg	In soil			
	0.1	0.1	Not detected	Not detected
OAC, mg/kg	In food			
Vegetable, whites,	0,1	0,2	0,05	0,02
Fish	0.2	0.2	Not detected	Not detected
Milk	0.005	0.005	0.006	0.006
Meat	0.005	0.005	0.2	0.2
Egg	0.005	0.005	0.1	0.05
Butter and fat	0.2	0.2	Not detected	Not detected

The limited concentration of sum of dioxins and dioxin-like PCBs (WHO-PCDD/F-PCB-TEQ) and sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180 were limited in the commission regulation (EU) No 1259/2011 [22] of 2 December 2011 amending Regulation (EC) No 1881/2006. The maximum levels for dioxins, dioxin-like PCBs and non dioxin-like PCBs in foodstuffs is described in section 5: dioxins and PCBs of the Annex to Regulation (EC) No 1881/2006 is amended as follows (table 4):

Table 4 - The maximum levels of sum of dioxins, sum of dioxins and dioxin-like PCBs , sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180 in foodstuff in EU

Foodstuff	Maximum levels		
	Sum of dioxins (WHO-PCDD/F-TEQ)	Sum of dioxins and dioxin-like PCBS (WHO-PCDD/F-PCB-TEQ)	Sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180 (ICES – 6)
1	2	3	4
Meat and meat products (excluding edible offal) of the following animals: — bovine animals and sheep — poultry — pigs	2,5 pg/g fat 1,75 pg/g fat 1,0 pg/g fat	4,0 pg/g fat 3,0 pg/g fat 1,25 pg/g fat	40 ng/g fat 40 ng/g fat 40 ng/g fat
Liver of terrestrial animals and derived products	4,5 pg/g fat	10,0 pg/g fat	40 ng/g fat
Muscle meat of wild caught fresh water fish, with the exception of diadromous fish species caught in fresh water, and products thereof	3,5 pg/g wet weight	6,5 pg/g wet weight	125 ng/g wet weight
Muscle meat of wild caught eel (<i>Anguilla anguilla</i>) and products thereof	3,5 pg/g wet weight	10,0 pg/g wet weight	300 ng/g wet weight
Fish liver and derived products thereof with the exception of marine oils	—	20,0 pg/g wet weight	200 ng/g wet weight
Marine oils (fish body oil, fish liver oil and oils of other marine organisms intended for human consumption)	1,75 pg/g fat	6,0 pg/g fat	200 ng/g fat
Raw milk and dairy products, including butter fat	2,5 pg/g fat	5,5 pg/g fat	40 ng/g fat

Continuation of table 4

Hen eggs and egg products	2,5 pg/g fat	5,0 pg/g fat	40 ng/g fat
Fat of the following animals:			
— bovine animals and sheep	2,5 pg/g fat	4,0 pg/g fat	40 ng/g fat
— poultry	1,75 pg/g fat	3,0 pg/g fat	40 ng/g fat
— pigs	1,0 pg/g fat	1,25 pg/g fat	40 ng/g fat
Mixed animal fats	1,5 pg/g fat	2,50 pg/g fat	40 ng/g fat
Vegetable oils and fats	0,75 pg/g fat	1,25 pg/g fat	40 ng/g fat
Foods for infants and young children	0,1 pg/g wet weight	0,2 pg/g wet weight	1,0 ng/g wet weight'

1.3 Polychlorinated biphenyls (PCBs)

1.3.1 Chemical and physical characteristics of PCB

Polychlorinated biphenyls (PCBs) a family of highly toxic chemical compounds consisting of two benzene rings in which chlorine takes the place of two or more hydrogen atoms. According the positions 2,2', 6 and 6' of chlorine, PCBs are called ortho, with positions 3,3', 5 and 5' called meta positions, and with positions 4 and 4' called para positions (figure 1) [23]. The benzene rings of PCBs can rotate around the bond connecting them. For example the two extreme configurations are planar (the two benzene rings in the same plane) and the nonplanar in which the benzene rings are at a 90 C angle to each other (figure 2).

PCBs consist in 209 individual chlorinated compounds, that are known as congeners and do not occur in nature. These compounds were specifically manufactured as additives to other oils because of their highly stable and heat resistant properties to breakdown. PCB congeners with the same number of chlorine atoms are known as homologs, and the homologs with different chlorine positions are called isomers. Non-ortho and mono-ortho substituted PCBs show toxicological properties that are similar to dioxins. They are therefore often termed 'dioxin-like PCBs'. Most other PCBs do not show dioxin-like toxicity [24].

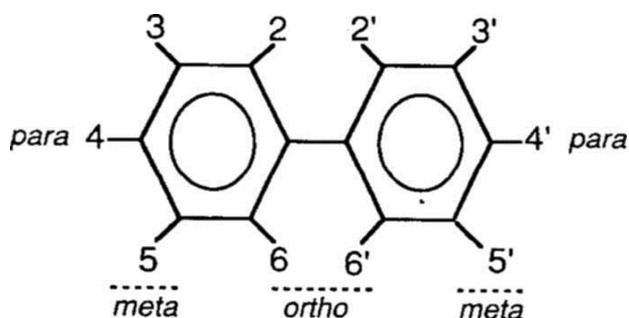


Figure 1 - General Chemical structure of PCBs. Para-, meta-, ortho- positions of chlorine

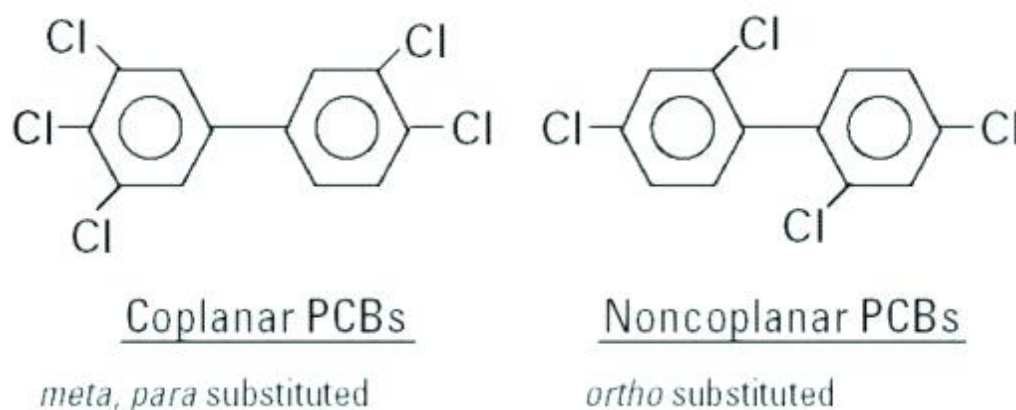


Figure 2 - Coplanar and Non coplanar positions of benzene rings of PCBs

An important property of PCBs is their general inertness. They resist both acids and alkalis and have thermal stability, high flash point (from 170-380 C). The density varies from 1.182 – 1.566 kg/L. This made them useful in a wide variety of applications, including dielectric fluids in transformers and capacitors, heat transfer fluids, and lubricants. They were used in a variety of primarily coolant, lubricant and hydraulic applications, where these properties were of design importance, before less toxic and persistent compounds were readily available. PCBs were widely used in electrical transformers as both a coolant and lubricant and in other electrical equipment because they aren't flammable and are good insulators. This application included diesel electric trains, capacitors and old fluorescent lights. They were also extensively used in hydraulic oils. Several PCB mixtures has been made with different trade names depending on the country: Aroclor (USA), Delor (Slovakia), Phenochlor (France), Clophen (Germany), Kanechlor (Japan), Santotherm, Fenchlor (Italy), Sovol (USSR) [25].

The toxicology of PCBs is affected by the number and position of the chlorine atoms, as substitution in the ortho position hinders the rotation of the rings. Non-ortho and mono-ortho substituted PCBs show toxicological properties that are similar to dioxins. They are therefore often termed 'dioxin-like PCBs'[23, p.18].

All PCBs are a widespread class of persistent organic chemicals that accumulate in the environment and humans [19, p. 778]. The accumulative feature is related with insolubility in water. The solubilities of PCBs in water are very low, for example for Aroclors 0.0027-0.42 ng/L. But, freely solubility in biological lipids of PCBs is associated with bioaccumulation in food chains and effect to the health effects [26, 27]. Due to their properties, PCBs has been prohibited in almost all industrial countries since the late 1980s but they still can be released into the environment from building paint and sealants and poorly maintained hazardous waste sites that contain PCBs [28].

The general way of exposure of population may be by ingesting contaminated food and by inhaling contaminated air, and in third way by dermal contact [15, p. 220]. Treated samples of animals show a LD50 ranging from 0.5 g/kg to 11.3 g/kg of body weight. PCB residues were detected in 8.5% of samples, with a maximum of 0.30 mg/kg fat, observed in a survey on the fat of domestic farm animals in Ontario,

Canada between 1986 and 1988. In a survey on foods in Vietnam, the highest levels of PCBs were detected in fish and shellfish, with levels of 760 and 1,400 ng/g fat. The main sources of PCBs in Vietnamese diets were cereals (including rice) and vegetables, and the daily intake of 3.7 µg/person/day was comparable to those of some industrialized countries. A survey on foods in India also revealed that the highest levels of PCBs were in fish, with an average of 330 ng/g fat. Again, the main source of PCB dietary intake (0.86 µg/person/day) was cereal and vegetable oil [29].

In evaluating the contamination situation by PCBs the six congeners (PCBs 28, 52, 101, 138, 153, and 180) were chosen as indicators for the occurrence of NDL-PCBs. As noted in the Scientific Panel on Contaminants in the Food Chain of EFSA noted in its Scientific Opinion related to the presence of NDL-PCBs in feed and food that the sum of the six indicator PCBs represented about 50 % of the total NDL-PCB in food [24].

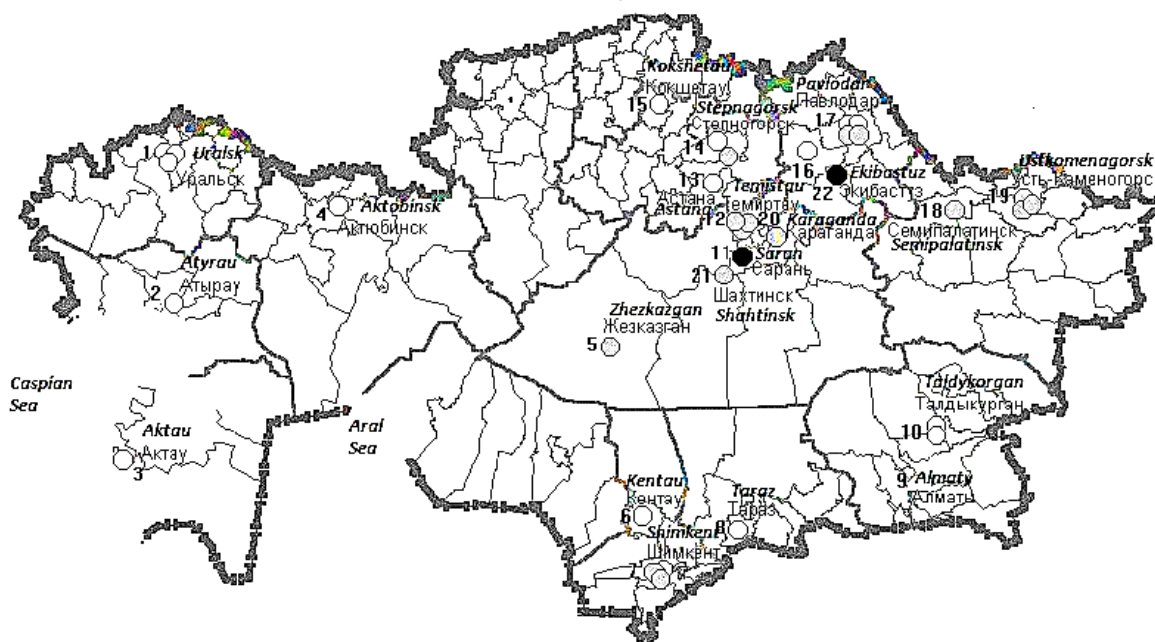
1.3.2 The main source of PCB exposure and PCBs-problems in Kazakhstan

In Kazakhstan the industrial POPs, such PCBs are obtained and used on the factories of energy (power and light) production, petroleum and chemistry industry production, as oil in transformers and condensators.

In country in terms of sectors placement using the PCBs containing equipment as follows:

- energy complex - more than 2,500 pieces;
- mining and metallurgical complex - about 20 thousand pieces;
- train transport - about 600 pieces;
- chemical industry - about 400 pieces.

All the enterprises of Kazakhstan in such sectors of economy can be potential sources of unintentional releases of POPs (figure 3).



circle with black fill - high; circle with a gray fill - medium; unfilled circle - weak.

The name of enterprises: 1. city Uralsk - JSC "Plant POLIGRAFIST ", JSC "Ural-plioplast. " 2 city Atyrau - JSC "Atyrau Refinery". 3 city Aktau - JSC "ACPO". 4 city Aktyubinsk - JSC "AZHS." 5 city Zhezkazgan - JSC "Kazakhmys". 6 city Kentau - JSC "Achpolimetall." 7 city Shymkent - JSC "Interkomshina", JSC "Yuzhpolimetall", JSC "SHNOS". 8 city Taraz - LLP "Kazphosphate". 9 city Almaty - JSC "Kazsabton", LLC "Plant of household chemicals", LLP "Gaudi Point", LLP "Renbou Point", JSC "Kazkhrom", JSC "Altyn-Diamond", LLP "ANT-ELCOM" , JSC "Teploenergooborudovanie" CJSC "Eurotech Industries Limited", LLP "Anna", LLP "SHZ", JSC "Kazremenergo." 10 city Taldykurgan - JSC "Taldykurgan Battery Plant" Ltd, "Kuat". 11 Saran city - LLP "Saranrezinotekhnika" 12 Temirtau city - LLP "Karagandahimprom", JSC "Mittl Steel Temirtau", Chemical and Metallurgical Plant. 13 Balkhash city - Mining and Metallurgical Combine. 14 Astana city (capital) - JSC "Zhairm." 15 Stepnogorsk city - TSGHK, JSC "Herbicides". 16 Kokshetau city - JSC "Plant household chemicals." 17 Pavlodar city - JSC "Maikainzoloto." 18 Pavlodar city - JSC "PHZ", JSC "Aluminium of Kazakhstan", JSC "PHNZ", JSC "" KazEnergoKabel. " 19 Semipalatinsk city - LLP "Kazakhkabel" 20 Ust-Kamenogorsk city - JSC "Kazahtsink", JSC "VKHMK", JSC "IrtysHMZ." JSC "UKTMK." 21 Karaganda city- "Kazstroyopolimer" Machine-Building Plant. 22 Shahtinsk city - TOO "Transenergo". 23 Ekibastuz city - GRES-2. "

Figure 3 - The potential sources of PCBs in Kazakhstan

In addition to this list must be added the numerous wells and oil and gas fields in western Kazakhstan. Also, the Baikonur cosmodrome in south west of the country, annually allocates tons pollutants such as heptyl and most important ecological problem of dried sea in the south-west Aral.

Kazakhstan as developing country, improve the sectors of industry as oil and gas, uranium industries, where factories and plants use transformers and capacitors containing PCBs [30]. During reconstruction, being part of the Soviet Union, Kazakhstan has placed strategic enterprises and defense facilities. Such enterprises have purchased the most stable electrical equipment, which in 1960-80 was filled with PCBs. Nowadays, in the country no production of PCB occurs. Before, at USSR time, PCBs were produced from 1934 to 1995. These PCBs containing equipments mainly were used as dielectric fluids in transformers, capacitors by name Sovol (mixture of tetra- and pentachloride biphenyls), Sovtol (mixture of sovol and trichlorobenzene) and there mixtures Trichlordiphenyls (mixture 85% Sovol and 15% a-nitronaftalin), Gexol (25% Sovol). It was also produced, as a plasticizer in the manufacture of varnishes and polymer materials, lubricants and fungicides to protect the hardwood [30, p. 45].

The major producer of PCBs were companies like "Orgsteklo" (Derjinsk city, Russia), 'Orgsintez' (Novomoskovsk, Russia), Vitinig (Ufa). The filling capacitors were implemented in next cities: Serpuhov (Russia), Ust-Kamenogorsk (Kazakhstan), Leninakan (Armenia), Chirchik (Uzbekstan) [7, p. 83]. However, for today not enough information is available about basic composition of Sovol or Sovtol, which

could be useful for more precisely assessment of PCBs contamination of Russia and Central Asia countries.

According to available data [31] regarding study of 3 samples of oil produced in USSR (sovol) in 1979 year, it has been found that they are similar in composition to the Aroclor 1254, mainly used in transformers, and to the Aroclor 1242 which contain lighter congeners, used to fill capacitors (table 5).

Table 5 - The main composition of sovol in sum of chlorine

Number of Cl	Sample 1 mg/g of oil	%	Sample 2 mg/g of oil	%	Sample 3 mg/g of oil	%
$\sum \text{Cl } 2$	0.76	0.1	2.97	0.5	86.3	20.2
$\sum \text{Cl } 3$	2.65	0.5	5.77	1.0	196	45.9
$\sum \text{Cl } 4$	87.9	15.6	100	17.7	108	25.3
$\sum \text{Cl } 5$	322	57.1	290	51.2	27.0	6.3
$\sum \text{Cl } 6$	141	25	155	27.4	9.20	2.2
$\sum \text{Cl } 7$	9.44	1.7	11.3	2.0	0.18	0.04
$\sum \text{Cl } 8$	0.20	0.04	0.15	0.03	-	
All	564		566		427	

According to these results, identified presence of congeners, like PCB 77, PCB 81, PCB 126 and PCB 169, are in the group of dioxin-like PCBs non-ortho PCBs and mono-ortho PCBs. The value of these congeners was 12.5 μg WHO-TEQ/g and 7.2 μg WHO-TEQ/g from mono-ortho PCBs. It is mean that the toxicity of sovol is very huge while TEF for them is very few: PCB 77 - 0, 0003; PCB 81-0, 0003; PCB 126 - 0,1; PCB 169-0,03 [8, p. 72].

PCBs still staying surveyed in Central Asia, e.g. about 70 000 tones in Ust-Kamenogorsk, Kazakhstan; 57 000 tones at Chirchik, Uzbekistan; 24 000 tones dispersed in Tajikstan [32]. According in other source of data, the total volume of PCB contaminated equipment are approximately estimated 980 tones and PCB containing wastes 250 000 tones [33].

According to studies in West -, Central Kazakhstan and available data, "hot spots» areas contamination with PCBs could be located in [7, p. 80]:

- Ust-Kamenogorsk Condensing Plant territory (Ablaketka village) and river banks; According to the known information from 1968 until the independence of the republic in 1990, TCB had been used as a capacitor fuel in the plant [33, p390]. After banned of TCB and for rehabilitation the leftovers quantity was 6-9 tons.

- The storage pond of the Ust-Kamenogorsk Condensing Plant; The rehabilitated PCB leftover and soil in plant have been taken to this pond. According data of Ishankulov (2007), the concentration of PCB in soil in the beach was 12.438 mg/kg and IN the water of pond 0.19 mg/kg. There is very big possibility of contamination of Irtysh river with ground water.

- Ekibastuz City power substation area. The maximum concentration of PCBs observed in the sample near Ekibastuz electrical substation, which amounted to 26200 mg / kg of soil [8, p. 98];

- Pavlodor Chemical Plant.

- Daryal-U - Territory of former military facilities in the northern Pri-Balkhash;

- Derzhavinsk polygon for military machinery destruction;

- Zhangiztobinsk polygon for military machinery destruction;

- Kostanai City power substation area;

Also, according to the first inventory, 22 companies or database have approximately 56,000 PCB capacitors, which is equal to 850 tons of PCBs in 2500 tons of equipment with PCBs (figure 4):

PCB transformers

- 107 units on Arcelor Mittal Temirtau

- 32 units on Stepnogorsk bearing plant

- 12 unit on Kazakhmys

- 4 units on Atyrau oil refining plant

PCB capacitors

- 16000 units on Aksu ferroalloy plant

- 15000 units on former Semey nuclear polygon

- 6000 units on former military area Darial U

- 1450 units on Kazzink

- 444 units on UKTMK


- about 500 units on KazMunayGaz

- about 500 units on Kazatomprom

- about 500 units on Kazakhstan Temir Zholy

- 338 units on Alatau Zharyk Company



 - PCB containing condensators

 - Battery for condensators


 - PCB transformers

Figure 4 - Placement of transformers and capacitors in Kazakhstan

Despite this data, there are little information about contamination of environmental objects, food and producing animals. It has been noted that in spite of the hot spots are located in north and east Kazakhstan, PCBs contamination have been reported in several publication about south and west parts of the country. For example, according to research work of Hydrology Institute [34], the contents of PCBs in sediments of downstream Syrdarya river identified a total of 6 individual PCBs congeners: 40, 41, 44, 52, 64 and 71. Higher concentrations were reported for PCB 40, present in a concentration of 2.1 µg/L, and PCB 44 in concentrations between 12 and 23 µg/L as well as the presence of indicator PCB 52 in relatively low concentrations of <0,09 µg/L. The identification of direct sources of pollution of these waters by pollutants is too hard. There are only speculations about the impact of so-called "historical" sources, because military installations operate for many years in the Soviet Union in this region. Consequently, the contamination of population by exposure to POPs is more a chronic exposure.

In a comparative study of the contamination of camel milk in Atyrau, Kyzylorda, Zhambul and South Kazakhstan oblasts, only samples from Kyzylorda oblast have high level (0,95 ng/g), and mainly PCBs 52 and 138 [35]. Also PCDD/Fs contamination of camel milk from Almaty, Atyrau, Aralsk, Shymkent were investigated. The concentrations of PCDD/Fs were higher in the Atyrau oblast. This result could be linked with oil extraction in this region [35, p. 359].

Some publications about contamination of human, more precisely in breast milk were available in south part of the Republic. In human breast milk from Almaty, Shymkent and two cotton growing area of South Kazakhstan Oblast (villages Djetisay and Kyrov), the cities nearest of the Aral Sea (village Aralsk and Kyzylorda city), and a site of petrochemical exploration on the Caspian Sea (Atyrau) were investigated. The mean concentration of total PCBs was 410 ng/g fat. Concentrations of six iPCB congeners (28, 52, 101, 138, 153, 180) were between 100 and 350 ng/g fat [36]. The mean concentration of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), one of the potentially most carcinogenic dioxin congeners were particularly high (19.6 to 118.2 pg/g fat) and represent six of the eight samples collected from the two cotton-growing districts (Djetisay and Kirov). According to the International Toxic Equivalent (I-TEQ), a mean concentration of TCDD was 20.1 pg/g fat (median 11.9 pg/g fat). However, the eight samples in the cotton growing districts had a mean I-TEQ of 57.2 pg/g fat (range 11.6 to 132.9 pg/g fat) [36, p. 1770]. The mean concentration for the proposed PCB-TEQ for three coplanar PCBs (PCBs 77, 126, 169) was 9.1 pg/g fat.

In another comparative study of PCBs in fish from several regions of Kazakhstan [37], the highest PCBs concentrations were measured in vobla fish from Atyrau. Those fish had total PCBs up to 250 ng/g. Moreover, the breast milk selected in Atyrau region was much higher (mean 820 ng/g fat) than in samples from other study areas (Shymkent, Aralsk, Kizilorda, Almaty and two cotton rural villages Kirov and Djetisay). Possible sources of the elevated PCB exposures in the Atyrau area may

be local industrial activities (refineries) or the combination of local and distant activities affecting the area throughout the Ural River Delta [37, p. 1250].

According to another study [38], the most PCBs contaminations of breast milk in Kazakhstan were in descending concentrations: PCBs 153, 138, 74, 180, 118, 99, 28, 156, 170, 187 and 105 [39]. The mean total PCB concentration in Kazakh human milk was 368 ng/g fat. The main transferred PCBs were PCBs in hexa-CBs group [39, p. 439].

A study of contamination of children from Aral sea region revealed that the PCBs was 1900 µg/kg in lipid of plasma of children, which was higher than in Europe [40]. Author noted that the possibility of exposure of toxic chemicals to these children in addition to direct sources of pollution was associated to poor nutritional status and eating contaminated food, which threat to their health [40, p. 190]. The main source of contamination is the dried Aral Sea which could expose the closed population.

Globally, information about impact of organic pollutants, especially PCBs on livestock products is not enough. Especially recent data is very few and do not include not all livestock products.

1.4 Organic chlorinated pesticides

1.4.1 DDT

As described above, the first group of POPs list of the Stockholm Convention includes 9 pesticides: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex, toxaphene, hexachlorobenzene.

Pesticide - is any substance or mixture of substances intended for: preventing, destroying, repelling, or mitigating any pest [41]. Pesticides have a high biological activity, the ability to migrate to food chains and represent a high risk to public health [42].

These pollutants are very stable, low volatile, non-polar, lipophilic and as a result, show considerable stability in the environment with a tendency to bioaccumulate, leading to their presence in foods, especially those high in fat [43].

General characteristics of this chemical compounds are

- their effectiveness towards numerous insect species;
- their high persistence;
- their lipophilicity.

After intensive used of organic pesticides, negative influence was revealed because of their persistence in the environment, and their tendency to accumulate in the food chain. Although not lethal, they directly or indirectly affected the fertility and reproduction of many wild species. For this reason, DDT and organochlorine compounds have been banned in agriculture since 1973 and heavily limited in the control of the carriers of diseases of human [44]. But, some countries continued to use DDT for various purposes. Currently in India, some countries of Asia and Africa are widely used DDT, contaminating surface water and groundwater [45].

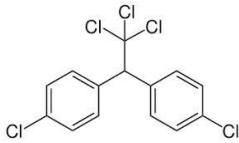
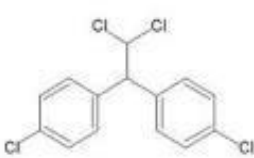
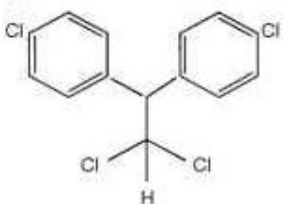
DDT was introduced in 1939 as a result of systematic research on its insect killing activity by the Swiss entomologist Paul Muller. It was used during the Second World War to protect soldiers from the spread of malaria, typhus and other vector

borne diseases. After the war, it was used in agricultural sector, to control diseases attacking the crops and agricultural fields [46].

According to some data [47], two million cases poisoning by pesticide were registered in the world, the majority occurring in developing countries rural residents. Until the end of the century the first agriculture pollutant was DDT.

DDT has 3 metabolites - Dichlorodiphenyltrichloroethane and its related compounds Dichlorodiphenyldichloroethylene (DDE) and Dichlorodiphenyldichloroethylene (DDD) and 4 isomers. The physical and chemical properties of DDT and their metabolites DDE and DDD is described in table 6 [48].

Table 6 - Physical and Chemical Properties of p,p'- and o,p'-DDT, DDE, and DDD

Property	p,p'-DDT	p,p'-DDE	p,p'-DDD
CAS number	50-29-3	72-55-9	72-54-8
Chemical structure	$C_{14}H_9Cl_5$ 	$C_{14}H_8Cl_4$ 	$C_{14}H_{10}Cl_4$ 
Molecular weight	354,49	318,03	320,05
Color	Colorless crystals, white powder	white powder	Colorless crystals, white powder
Physical state	Solid	Crystalline solid	Solid
Melting point	109 C	89 C	109- 110 C
Boiling point	260 C	336 C	350 C
Density, g/cm ³	0,98 – 0,99	No data	1.385
Solubility: mg/L at 25 C Water Organic solvents	0.025 Slightly soluble in ethanol, very soluble in ethyl ether and acetone	0.12 Lipids and most organic solvents	0.090 No data
Partition coefficients: Log Kow Log Koc	6.91 5.18	6.51 4.70	6.02 5.18
Vapor pressure	1.60x10 ⁻⁷ at 20 C, torr	6.0x10 ⁻⁶ at 25 C, torr	1.35x10 ⁻⁶ at 25 C, torr
Henry's law constant	8.3x10 ⁻⁶ atm-m ³ /mol	2.1x10 ⁻⁵ atm-m ³ /mol	4.0x10 ⁻⁶ atm-m ³ /mol

DDT, due to their persistently and bioaccumulation, has been found in all matrices of the environment, even in area where it has been never used. Even in organism of penguins, the concentration of DDT was 0,024 mg/kg, in spite that they were never used in their near environment [49].

The influence of DDT on humans and animals was studied in detail by many scientists around the world. For example, in the 1993-1995 studies, lipid-adjusted DDE levels from women living in Mexico city was 6,66 ppb in mammary adipose tissue and 0,594 ppm in total breast milk [17, p. 587]. In the breast milk of Egyptian women, the average of total DDT detected was 57.59 ppb and an estimated daily intake of total DDT for breast feeding infants was 6.90 µg/kg BW /day [50].

Research in the field of transition contaminants in the food chain were investigated on such objects as cattle, small ruminants and laboratory animals. DDT is not highly acutely toxic to laboratory animals, with acute oral toxicity (LD50) in the range of 100 mg/kg BW for rats to 1,770 mg/kg for rabbits. Significant amounts of DDT were found in the milk of dairy cows receiving feeds contaminated with Organic Chlore Pesticides (OCPs). Taking into account the widespread use of DDT, its accumulation in food may pose a threat to public health, particularly young children. Therefore, standards have been set on their content in natural food and objects of the environment.

1.4.2 The DDT use and status in the environment of Kazakhstan

In Kazakhstan during the last 30 years, more than 700 pesticides belonging to different classes of chemical compounds were used in practical applications [48]. According to the regulation list of approved pesticides (insecticides) in territory of Kazakhstan from 2013 to 2022, there are 560 types of pesticides belonging to different groups of chemical compounds [51]. For protection from pests, diseases and weeds, every year about 6000-7000 kg/l of pesticides were used in Kazakhstan. This volume is gradually increasing: if in 2000 the volume of used pesticides was 6807,7 thousand kg\l, in 2009, it increases to 8144,5 thousand kg\l [52].

Total cultivated area of crops of the country for the 2012 year amounted to 21 190.7 thousand hectares. The largest in crops and bean cultures are: Kostanay (5 148.2), Akmola (4 758.5), Noth-Kazakhstan (4 497.5), East-Kazakhstan (1 217.7), Pavlodar (970.8), cotton and other vegetables: South-Kazakhstan (742.2), KyzylOrda (159.8), Zhambul (527.3), Almaty (889.7) oblasts (in thousand hectares) [53]. All these territories were used and continue to use various types of pesticides. In Kazakhstan there are about 25 million hectares of plough-land and until 1990s pesticides were used all over these lands. The total annual volume of pesticides was 35,000–40,000 t. In 1986–1995 the volumes of chemical plants protection were reduced to 1800 t. The pesticide load on 1 ha of ploughed field was also reduced. Since 1998 pesticide volumes increased and currently make 9,000–11,000 t. Herbicides and fungicides composed the major part of plants protection [54]. All these amounts of pesticides can be the main source of contamination of the territory of Kazakhstan.

One of the ways of pollution of the country, especially in region close to Russia, is the production of DDT from 1946 to 1990 at Soviet Union time [55] and its use in Kazakhstan in veterinary and medicine field till 1990s.

According data of GlavRybolov Kazakh SSR (Main Department of Fishing in Kazakh Soviet Social Republic) in 1985 on the part of the river Syr Darya from the border with the removal of the Uzbek SSR to Kazalinsk (part of Kazakhstan), water contained 4.9 mg / l of DDT in 1986 - 0.3 mg / l, 0.2 g / l of DDE, 11.4 g / l DDD; in 1987 - 0.7 mg / l of DDT, 0.4 mg / l DDD and 0.4 g / L DDE. All these years in the area, deaths of fish and birds were observed, their bodies containing up to 200 mg / kg of DDT and metabolites [56].

The presence of these pesticides in the environment of Kazakhstan as pesticides residues from USSR time is till important after the independence of the country. The number of storehouses, where pesticides were stored in the Soviet period is discussed in different papers: according to F. Bismildina [57], there are 974 warehouses, including 411 in emergency condition which accumulated 574 tons of pesticides and 54 thousand units of packaging, not buried. According to A. Nazhmetdinova [58] hundreds of tons of pesticides have not been buried, and the number of warehouses was 1280, in an emergency state – 236. Nowadays, in Almaty region, a total of 352.6 tons and Akmola region – 36 tons of obsolete pesticides are registered [59]. Obsolete pesticides used in 50-60th in last century are still found in analyzed soil samples. Contamination of soils may be characterized by the following figures: the average concentration of DDT residues is 1.2 to 5.9 times higher than the maximum allowable concentrations.

The presence of DDT was detected in water, sediments, aquatic plants and fishes over 1/3 of the surveyed water reservoirs in Kazakhstan [60]. The presence of DDE in the pond with an average concentration of 114 µg/l was reported near the former warehouse storage of pesticides in the village Beskaynar in Almaty region [61].

Preliminary inventory of banned pesticides were carried out in 2001 in the framework of UNEP Chemicals. As a result, it was found more than 1200 tons of pesticides and their unknown mixes. Data of the amount of pesticides necessary to bury are varied [62]. According to the Ministry of Agriculture in 2003, 9770 kg in Akmola, 57215 kg in Almaty region, 50550 kg East Kazakhstan Oblast, 80393 kg Zhambul region, 1119 kg South Kazakhstan Oblast, Aktobe region 42925 kg of pesticides are disposed in the Republic of Kazakhstan. Now, 11 burial grounds are implemented, four of which are in operation [63] (figure 5)

Soils surrounding such storehouses, which are out of operation at present, are polluted with DDT and HCH isomers in amounts exceeding maximum allowable concentration (MAC) more than 78 times [64]. DDT is now banned in all developed countries. However, it is relatively cheap and is still regarded as a good tool in certain situations, such as the control of malaria-carrying mosquitoes. In Kazakhstan DDT is still used as a drug “Dust”. These pesticides are still very cheap and sold in local markets.

Data on the concentrations of organic chlor pesticides in the environment and food in Kazakhstan is few. Basically, published data are the results of monitoring of the main pollutants [65, 66].



1. Taskalinsky region, Western Kazakhstan oblast;
2. Aktobe, Aktobinsk oblast;
3. Naursum region, Kostanai oblast (200t);
4. Shortandinsky region, Akmola oblast;
5. Abai region, Karaganda oblast;
6. Pavlodar Chemical Plant, Pavlodar, Pavlodarskaya oblast (1000t);
7. Kuibyshev village, Aksusky region, Pavlodar oblast (2000t);
8. Disposal site of Zhangiz Tobe, Zharminsk region, Eastern Kazakhstan (112 t);
9. Disposal site of “Ulba” company, Ust Komenogorsk, Eastern Kazakhstan oblast (20 535 t);
10. Karamergen village, Saragashsky region, Southern Kazakhstan (32 t);
11. Esilsky region, Northern Kazakhstan oblast.

Figure 5 - Burial of pesticides in Kazakhstan

In camel milks from Atyrau, Kyzylorda, South-Kazakhstan and Almaty region, HCHs (beta, delta, and only in the Kyzylorda oblast also gamma HCH) and DDT were found in the Kyzylorda oblast (0,8 µg/kg) and Chlorothalonil in Shymkent (0,5 µg/kg) [67]. The presence of these pesticides is linked to the cotton cultivation areas. The level of beta HCH and DDT compounds determined in blood of children from this region was approx. 5000 ppb [40, p. 190].

In comparative study of breast milk in Almaty, Shymkent and two cotton growing area of South Kazakhstan Oblast (villages Djetisay and Kirov), the cities nearest of the Aral Sea (village Aralsk and Kizilorda city) the levels of p,p'-DDE in this study were between 240 and 10,540 ng/g fat, with a mean of 1,960 ng/g fat. The DDE level in breast milk was high (3 330 ng/fat milk) in cotton growing regions, in women lived in villages Kirov and Djetisay in south Kazakhstan [37, p. 1255]. This can be link to the use of pesticides for cotton cultivation.

In other study [36, p. 1770] of organic pollutants in breast milk was in mean concentration total DDT of 1,730 ng/g fat.

In study of toxic chemicals in the blood of children from villages near to Aral sea [40, p. 190] the DDE concentrations were 2800 µg/kg and 3200 µg/kg of plasma lipid, when in the blood from Stockholm, it was 140 µg/kg and 80 µg/kg of plasma lipid. DDT concentrations were between 500-600 µg/kg of plasma lipid, when in the blood of children from Stockholm it was 9 µg/kg of plasma lipid. This very high difference in concentrations corresponded with the use of large quantities of organic pesticides in south part of Kazakhstan, originates from the Syr Darya River which flows into the Aral Sea. However, under the Soviets, the waters of the major rivers feeding the Aral Sea were diverted to irrigate cotton fields, with the result that the Aral Sea has shrunk to one third of its former size, and what is left becomes extremely salty and highly contaminated, especially with pesticides [68].

1.5 Transfer of POPs to domestic animals

The transfer of POPs was studied on cattle/bovine [20, p. 1050], sheep [69], goats [70] and hens [71]. These pollutants may enter the tissues in a variety of ways. The main way of contamination of food animal origin of via contaminated feed [72] and pathway to the largest livestock appears to be related to the ingestion of contaminated environmental matrices such as soil. POPs contamination can arise from the atmospheric deposition on to crops or via contaminated feed. The contribution of matrices to the global exposition to POPs for example in cattle shows 45-95% in soil, 5-55% in grass and less than 1 % in air [29]. According to Healy (1968) and Thornton and Abrahams (1983), a lactating ruminant may ingest daily from 1% to 10% soil when grazing. In another study [73] about soil intake related to grazing conditions, dairy cows would ingest daily less than 250 g of dry soil. In arid conditions, dry soil intake by dairy cows in intensive rearing systems can increase up to 1 kg/day [73, p. 315]. But, this data can't explain the soil intake for other ruminants. For example, the small concentrations of organic pollutants in the camel milk from Kazakhstan can be explained by the specific prehensile behavior of camels and would make them less exposed to ingest pollutants via the main accumulation vector soil. Anyways, soil contamination could lead to contaminate food of animal. As described above the soil contamination with PCBs and DDT is a major environmental problem in the country.

According studies of MacLachlan (2009) once ingested, lipophilic pesticides or other chemicals may be absorbed from the intestine to the systemic circulation via portal blood, and may be subject to metabolism by the liver before entering systemic circulation. Chemicals with high lipid solubility tend to concentrate in tissues with higher fat content, such as adipose tissue, brain, liver, kidney and, in the case of lactating animals, milk. The presence of a chemical in tissues and milk is also affected by its degree of biotransformation and its rate of elimination from the body.

The morphological and physiological characteristics of the gastro-intestinal tract in farm animal species largely determine the rate of absorption of a contaminant [74]. In other references [75] described the transfer of POPs to the animal's feed can be readily absorbed into the body through the lining of the digestive system and either

metabolized or stored in body fats. A large quantity of lipid is required for the production of eggs, the development of embryos, and in the case of mammals, the production of milk to suckle young. Hence, these are important ways in which POPs can be transferred from a female of some species to the calves.

There are several methods to assessment the transfer of pollutants to domestic animals for example the estimation of transfer of contaminants from daily used feed to the livestock estimated as:

$$TF = \frac{C}{intake}$$

where TF - transfer factor; C is the residue level in the relevant tissue or milk and *Intake* is the level of residue in the feed expressed on the basis of mg residue per kg of daily feed [72, p320].

Also, for estimation of transfer of pollutants used estimation of carry over rate (COR). According to McLachlan and Richter (1998), COR is an ideal parameter to describe contaminant transfer in lactating ruminants. Indeed, the COR is not strongly influenced by lactation rate, body fat weight or the animals diets [13, p. 28].

$$COR = \frac{output}{input} * 100$$

COR is the carry-over rate (%); output – is pollutant concentration in milk at steady state (plateau); input – is pollutant concentration in diet.

1.6 Camels and environmental pollutants

The data about the environmental contamination of camels' products are very few. In a comparative study achieved in Sharkia Province, Egypt, regarding the detection of organochlorine pesticide residues in camel, cattle and sheep, the residual concentrations of all the pesticides (DDTs, hexachlorocyclohexane isomers (HCHs), lindane (c-HCH), aldrin, dieldrin, endrin, hexachlorobenzene (HCB), toxaphene, and chlordane compounds) detected in camel carcasses were lower than those detected for cattle and sheep (table 7) [76].

In experimental camels from Kenya, the transfer of radionuclides ¹³⁷Cs, ⁸⁵Sr, ¹³¹I, ²¹⁰Po, ²¹⁰Pb and ²³⁸U from feed to camel's milk was estimated to be lower compared to other milk producing domestic animals [77]. In this study, it was demonstrated that the excretion of radionuclides by milk was slower than in milk of cow.

Table 7 - The concentration of pollutants in tissues of camel, cattle and sheep

Sample	DDT (ng/g wet weigh t)	HCHs (ng/g wet weigh t)	Lindane (ng/g wet weight)	Dieldrin (ng/g wet weight)	Aldrine (ng/g wet weight)	Endrin (ng/g wet weight)	Toxaphe ne (ng/g wet weight)
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Continuation of table 7

Muscle	Camel	13.9	2.4	0.33	0.15	-	Not detected	-
	Cattle	17.9	4.58	0.72	0.62	-		0.14
	Sheep			20.3	3.72	0.45		0.198
	Camel	34.6	25.5	3.26	3.07	0.59		0.12
Liver	Cattle	57.2	46.1	6.06	6.19	2.46	1.17	-
	Sheep	49.6	35.2	5.16	3.19	1.79	1.87	0.30
	Camel	25.4	21.7	1.83	2.09	-	1.24	0.36
Kidney	Cattle	36.3	33.3	5.26	4.17	1.75	0.47	-
	Sheep	25.3	18.6	2.58	2.65	1.39	0.68	0.22

Thus, physiology and metabolism as well as the size of the different species may explain some of those differences.

In a comparative study regarding pesticides (DDT, DDE, deldrin, eldrin and lindane) of meat and fat samples from sheep, cattle, goat and camels in different regions of Iran [78] lowest concentration was detected in camel and highest concentration in sheep.

In Kazakhstan, despite environmental context described previously, the results show weak contamination of the samples, within the LOQ (0.1 mg/kg), except milk from Kyzylorda where some traces were observed: 0.2 and 0.25 mg/kg for PCB 52 and PCB 138 respectively, what is clearly under the new European regulation 1259/2011. The low level of indicator PCBs in these samples underlines the question of the link between the localized PCB charges and camel herds moving in a wide area. In this way, a strong dilution of time-point exposure could lead to low concentrations of pollutants where the camels are probably exposed only for short periods. Elsewhere, the specific prehensive behavior of camels would make them less exposed to ingest pollutants via the main accumulation vector soil. Moreover, a low efficiency to digest lipids and lipophilic compounds combined to a huge storage aptitude in the humps may lead to less excretion in milk. Therefore, there is big importance of study of the camel milk kinetics and possibility of storage in hump of organic pollutants.

1.7 The camel as study model for metabolism of pollutants

Camels have a special characteristic as a biological model among all farm animals, and in general all mammals. Feature of camels is the ability to survive and adapt to difficult environmental conditions. Metabolic studies of PCBs and DDT in the body of *Camelus bactrianus* allow to understand the adaptive ability of survival in polluted environments. In studies of comparative effect of organic and inorganic selenium supplementation on selenium status in camel observed metabolism of selenium in camel organism more lesser than cattle [79]. Previously, similar studies were conducted on laboratory animals or on cattle. Physiological characteristics of laboratory animals are considered from the standpoint of comparison with human physiology. Impact of these pollutants helped to get a general idea, as it could affect

the humans. Studies on the sheep and goats conducted for control the meat of these animals object of the food chain of human. On one hand these studies supplement scientific data as a potential contamination object in the food chain. On the other hand, studies on such a special biological models as *Camelus bactrianus* allow to better understand the biological intake of pollutants such as PCBs and DDT. In addition, it is necessary to take into account that in the desert regions the camels are sometimes the only type of livestock; as a result they are the only source of milk, meat and wool for humans.

1.7.1 The camel in Kazakhstan

Nowadays, livestock in Kazakhstan mainly includes cattle, sheep and goat, birds, horse and camel. The population use horse and camel breeds in addition to cows for dairy production and all types of these animals for meat. The main livestock regions for camel are south, south east, east parts of the country [80]. In Kazakhstan two species of camels and their hybrids are cohabiting. Nowadays, 176 thousand heads of Camels in Kazakhstan.

If we consider the historical development of the camel in Kazakhstan, according to the Veterinary Administration of the Ministry of Interior of Russia Empire in 1892, there were 1,210,800 heads of Camels. In 1916, it's increased to 1,414,800 heads. After the Civil War in 1920 the Camel number decreased to 669,800 heads. Hunger and "jute" in the territory led to a drastic decrease camel number to 400 thousand. In 1932 with the adoption of the new economic policy of the USSR camel population in Kazakhstan was 987,500 heads. In 1941, during World war in Kazakhstan the number of camels amounted to 104,600 head. and until 1993 camel developed steadily and reached 148,800 heads. In these years the camel breeding system of Kazakhstan produced an average annual milk 4346,1 tons, meat 5300 tons and 713.8 tons of wool [81, 8-9 c].

From 1993 to 1998 the camel breeding part of country worked in connection with the transformation of the agricultural sector of the economy of Kazakhstan and the transition to a market economy, the industry experienced a decline of camel and livestock decline to 97,400 heads.

The population of camels increased from 115 thousand in 2003 to 170 thousand heads in 2010. It depends on of the policy of the Kazakhstan. For 2001-2005 in Kazakhstan were completed major changes in the agricultural sector, and created favorable conditions for the development of farmers. In 2007 the total amount of kazakh breed Bactrian camels was 83,100 heads, the arvana and Kazakh types of dromedary were 27,600 heads and hybrids was 33,000 heads. In 2010 and 2014 years camel breeding system stay stable. For the end of 2013, in country camel numbered 162,000 heads and changes in the last 10 years described in the figure 6

In Kazakhstan live double-humped (*Camelus bactrianus*) and one-humped (*Camelus dromedarius*) camels as well as hybrids at different levels of hybridization. Bactrian camel is the species historically present in the colder part of Asia (Mongolia, NW-China and Kazakhstan) as these animals are better adapted to the strong winter by developing a thick woolen coat and their higher milk fat content to nourish the calf [82]. There are different breeds as Kalmyk, Mongol and Kazakh Bactrian camels.

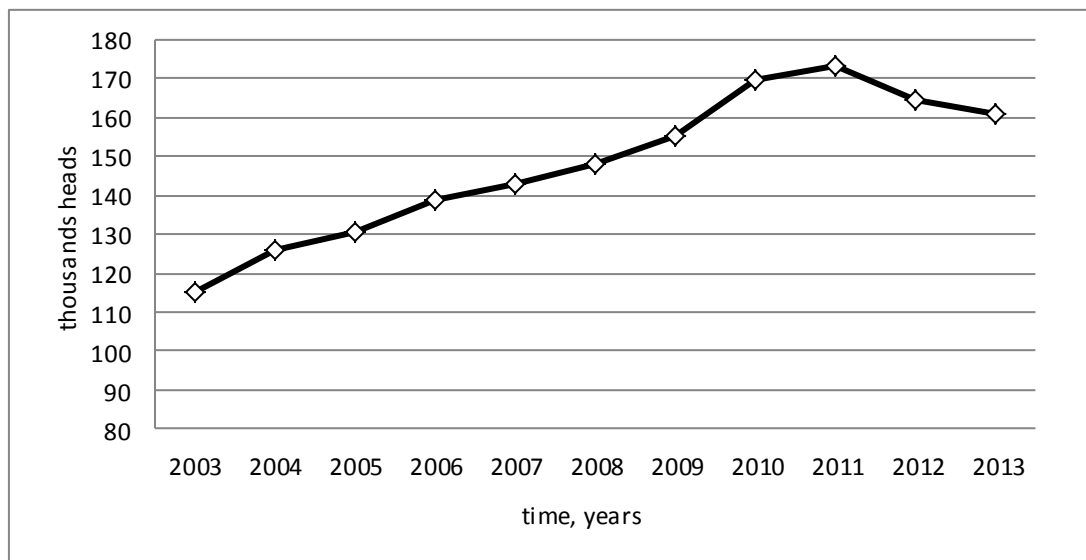


Figure 6 - Dynamic of changing of camels' number in Kazakhstan from 2003-2013 y.y.

Generally, Bactrian camels are known to be less productive. A comparison of milk composition between species in different Kazakh herds [83] showed the increasing of fat and protein content in milk of Bactrian camels in comparison to dromedaries and lower milk density in Bactrians compared to this density in hybrids.

In Kazakhstan main camel breeding regions are Mangistau, Kyzyl Orda, Atyrau, South Kazakhstan (figure 7).

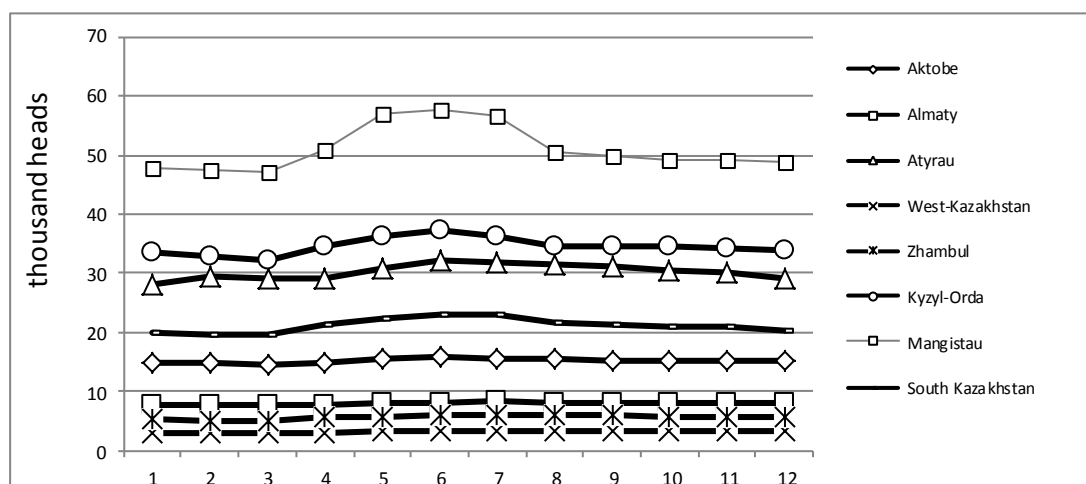


Figure 7 - Distribution of Camels in territory of Kazakhstan

1.7.2 Description of Bactrians in Kazakhstan

The main characteristics of Bactrian are long massive body on relatively short legs and nice overgrown wool [82, p. 100]. High quality wool is recorded in Bactrian living in areas with severe winter, without suffering from the cold. The front part of head of Bactrian is wider in their sockets, with relatively short facial bones. The neck is shorter than dromedary but more curved. In Kazakhstan, live all 3 breeds of Bactrians as described before: Kazakh, Mongolian and Kalmyk. According to available data [84] in NIS (New of Independent States) counties 92% of Kazakh breed Camels lives in Kazakhstan, 8% in Russian Federation.

Table 8 - The description of Bactrian breeds in Kazakhstan [86]

Breed	Country	Characteristics and breed
Kalmyk	Kazakhstan	Adult weight 775 kg (male), 595 (male). Height 190 cm (male) and 182 cm (female).
Kazakh	Kazakhstan, Russian Federation, Kazakhstan	Adult weight 700 to 750 kg (male), 585 to 650 (female). Height 180 to 196 cm (male) and 174 to 180 cm (female). Kizylorda, Mangistau, Atyrau regions
Mongolian	Kazakhstan, Russian Federation, Turva Republic, Mongolia	Adult weight 525 kg for male and 493 kg for female. Height 172 cm in male, and 167 cm in female

Kazakh Bactrians. Depending on their geographical location different Kazakh Bactrians are described in detail and proved in the form of genetic types (table 8) [85]:

- Uralo- Bukeyev type: most large animals, common in the north of the Caspian Sea (live in Atyrau, West Kazakhstan and Aktope regions);
- Kyzylorda type: a smaller-sized animals, spread around the Aral Sea and along the course of the Syr Darya River (South part of Aktope and Kyzylorda);
- Ontustik-Kazakhstan type (the South Kazakhstan): Kazakh Bactrian camels are small, but have all the productive characteristics of the breed, common in the South (South Kazakhstan, Zhambyl and Almaty region).

On the other hand, the more productive dromedary population is widespread in the southern part of Asia and especially the Turkmen Arvana breed is present in the overlapping zone of both populations on the territory of Kazakhstan. It originated from Turkmenistan, for milk production [86]. Therefore, Kazakh camel breeder can hybridize these species to produce fertile off spring for dairy purposes [87] which would cohabit in the same herd. Milk reproduction of first 7 months of this species is 1200 liters.

Kalmyk Bactrians amounted approximately 4500 head [84, p. 20]. Breed was obtained by crossing the best Mongolian and Kazakh camel Bactrian species, followed use in his XVI- XVII centuries by nomadic Kazakhs in Astrakhan, Saratovka, Orenburg, Omsk, and Volgograd province of imperial Russia [88]. This is the smallest breed, distinguished by its size, weight, tall and good bone. Also, they have good wool productivity and give wool high luminance quality. Body weight, depending on in-breeding type, ranges from 560 to 718 kg. The body weight of colts is 51 kg on average, which is 7% of the body weight of the Camel (Terentiev et al.1975). Milk production for 18 month of this species is 1200 liter (from 769 to 1717 l.). The fat content of milk is 6,9%.

Mongolian Bactrians amounted 200,000 heads. This breed was bred in Mongolia, in the Republic of Tuva, the Russian Federation and Kazakhstan. The total population in our country is less than 1,500 heads. This is the smallest species of the Bactrians.

This breed distinguishes two offspring (under breed):

- Hanyn hetsiyn huren. Live weight of 570-600, wool yield of 10 kg, height 170 cm withers.

- Galbyn goviyn ulan. Live weight of 630 kg male, wool yield 11 kg, height 172 cm at the withers.

They were brought to Kazakhstan in 1936 from Mongolia. Usually this breed is used for work. Milking production for 17 month is 319 l. The fat content of milk is 5.65% (table 9).

Table 9 - The average measurements and productivity of females Bactrian's of Kazakhstan [82]

Species	distance between humps, cm	Height of chest, cm	Length of trunk, cm	Girth of chest, cm	Girth of pastern, cm	Wool, kg	Yield milk perday, l	Body weight, kg
Kalmyk		95,0	160,0	229,5	20,0	5,7	5,0	600-650
Kazakh	172,5	88,0	151,8	216,1	18,9	5,5-6,0	6-8	500-560
Mongol	166,3	85,0	146,5	207,0	18,2	5-5,5	5-7	about 500

1.7.3 Description of Dromedary in Kazakhstan

The approximately amount of dromedary in Kazakhstan 15000 heads. In Kazakhstan one breed of Dromedary is available: it is Arvana. Reared mainly in the southern regions of Kazakhstan, it originated from Turkmenistan, selected for milk production.

Turkmen breed has are 4 types of inbreeding [89]:

-Sakarchagansky (Сакарчагинский) milk-meat type. Withers height -188 cm, body weight - 720 kg. Milk yield in 12 months of lactation - 3500 liter, with an average fat content of 3.5%.

-Erbentsky (Ербентский) milk type. withers height - 178 cm, body weight - 610 kg. milk yield in 12 months of lactation 4 400 kg, with 3.3% fat

-Iransky (Иранский) meat and milk interbreed type. the height of the withers for males 185 cm 178 cm for females. Live weight 650-550 kg. milk yield in the 12 months 3200 kg, with a fat content of 3.3%.

-Kazakh (Казахский) meat and dairy interbreed type. The height of the withers for males - 185 cm, 180 cm for females. Bodyweight males 750 kg, females 580 kg. milk yield in the 12 months 2800 kg, with an average fat content of 3.8%

1.7.4 Description of Hybrids in Kazakhstan

Different levels of hybridation have occurred, resulting in a wide range of crossbreeds [90]. Crossbreeding is aimed at obtaining crosses of the second and third

generation. Breeding of the crosses inter species the type of the improved camels with increased live weight, hair cover and viability.

The investigations of interspecific hybridization, carried out for a number of years by some authors, have shown the impossibility of maintaining hybrid vigour by breeding the first generation hybrids inter se or by grading to either of the initial species (table 10). Maintenance of heterosis through crossbreeding has given positive results: crisscrosses (Kez-nar and Kurt-nar) had higher milk yields and good meat characteristics. About 70-75% of hybrid females came on heat 20-25 days after calving, which meant 20-30 extra calves from 100 females in the next year.

Table 10-Performance of hybrids camel

		Gestation length (days)	Live weight (kg)	Milk yield in 12 month (kg)	Fat in milk %
Bactrian (Kazakh)		415	611	1750	5.8
Nar-maya	Dromedary x Bactrian	410	670	2955	4.6
Iner-maya	Bactrian x Dromedary	400	605	3563	3.5
Kospak	Backcross of Nar-maya to Bactrian	390	644	1925	4.6
Kurt	Backcross of Iner-maya to Dromedary	380	535	2544	4.1
Kez-nar	Dromedary x Kospak	385	650	3876	4.6
Kurt-nar	Bactrian x Kurt	387	640	4565	4.5
Dromedary (Turkmen)		385	558	4000	3.5

Breeding the crisscrosses inter se, however, led to decrease of live weight. This made necessary continuation of the work, consisting in the investigation of different methods of crossing of hybrid females with the sire, Kurt IV, also of hybrid origin, to find out possibilities for maintaining the heterosis and obtaining high milk yielding animals giving 4500 litres of milk, with the average butterfat content of 4.5% or more and preserving the desired qualities in subsequent generations as well.

Experiments prove that the progeny of the sire, Kurt IV, (produced by four generations of inter se breeding of the Kurt hybrid) is markedly different after 6

months of age from their test contemporaries of the same age by greater live weight, more intensive growth and development. Provided that the pasture fattening in spring and autumn is good, each of them can boast 1500-2000 g average daily weight gain. The well-developed lactating females thus obtained are an important reserve for replenishing the camel stock.

1.8 Feeding of Camels in Kazakhstan

The nutritional value of plants grazed by Camels is important to know for assessing the milk yield and body condition of animals.

Camel is a grazing pastoral animal. Pastures are the primary food source all the season in the year in Kazakhstan. In the autumn and summer vegetation specific camel pasture represented by such food plants as *Alhagi* (zhantak), *Artemisia* (wormwood), *Kochia prostrata*, (prostrate summer cypress), *Lucanidae* (Pinch beetles), *Echinochloa crusgalli* (barnyardgrass), Australian salt grass, *Rubus triflorus* (dewberry), *Atriplex* (Alabota), *Haloxylon aphyllum*, *Climacoptera fleshy*, *Glycyrrhiza glabra* (Spanish licorice), *Zastazostis splendens*, *Climacoptera lanata*, *Bromus inermis*, *Salsola arbuscula*, etc. And in autumn, large place of grazing are occupied by halophytes: *Anabasis salsa*, torgayoty, kuyrek, four, *Kochia prostrata* (prostrate summer cypress) *Atriplex* (Alabota) [91]. The nutritional value of plants grazed by Camels in Kazakhstan is described in following table (table 11).

Table 11-Nutritional value of pasture plants of Camels in Kazakhstan

Plant	Family	Protein in flower (%)	Digestible protein (%)	Ash(%)	fat	Microelements (%)
<i>Alhagi</i>	Legumes	12.6	6.9	6.3	4.1	Ca – 0.23
<i>Climacoptera fleshy</i> <i>Atriplex</i>	Goosefoot Goosefoot	7.2 11.8	3.8 3.2	27.8	15.1 2.0	Na – 10.2 P, Ca – 0.6-0.7 K -2.78 Na – 4.92 Ca – 0.75 Vit.C– 72.6mg/kg
<i>Poa bulbosa</i>	Cereal	30	7-8			
Pinch beetles	Goosefoot	11.7		11.9	1.6	K -2.93 Ca – 0.61 Na – 0.57-1.13
<i>Rubus triflorus</i>	Goosefoot		7.1-14.8		18.2- 31	1.5-3.2
<i>Bassia prostrata</i>	Goosefoot	8.4-17	14.7		3.5- 4.3	

Continuation of table 11

Artemisia	Grass	19.2	30.2			
Australian salt grass	Goosefoot	7.8-10.7	3.5-6.3		1.8-1.9	
Haloxylon aphyllum	Goosefoot	10-12		16.6-30.3	1.6-2.3	Na – 36.7-123.4 Ca – 11.6-21.8 K – 11.2-22.2
Poa bulbosa	Grass	30	7-8			

The plants are grazed in early-spring and spring: bulbous bluegrass - konyrbas (*Poa bulbosa*), Kiyak, zhaukiyak e.c.t,

In spring and summer times, the plants of family legumes are more grazed while in autumn-winter and early spring times haloxylon, artemisia are more important. Totally, the amount of plants grazed by Camels in Kazakhstan is approximately 35 species [92].

1.9 The camel products (milk, meat, wool) as way of excretion

Camel is a unique animal having the ability to survive and produce with low cost of feeding under harsh conditions compared to other livestock. It is a good source of milk and meat in areas where the climate adversely affects other animal's production efficiency. According to the literature the productivity of Camels are grouped to the following types:

- meat and dairy;
- meat and milk and wool;
- milk and meat and wool;
- meat and wool;
- dairy Camels.

1.9.1 Camel milk

According to the database of FAO [93] camels generally are kept for milk production in Africa and Asia and in sub-Saharan Africa and contribute about 7 percent of total milk production.

Camel milk is an important in the nutrition of the population of arid zones. Depends on breed of Camels the milk composition, milk yield are not the same.

All species of camels: Dromedary, Bactrian and their Hybrids are known for their ability to produce milk and are achieved mainly for milk production. The camel milk composition of have been published in several books, articles and have been done the meta analysis of articles according content [94] (table 12). The main composition of camel milk in g/100 ml in the was 3.82 ± 1.08 for fat matter,, 3.35 ± 0.62 for total protein, 4.46 ± 1.03 for lactose, 12.47 ± 1.53 for dry matter and 0.79 ± 0.09 for AsH. The milk composition of each species of Camels in Kazakhstan described in table 9 [94, p97].

Table 12 - The camel milk components in Kazakhstan for Bactrian camel, dromedary and hybrids

Species	FM	TP	DM	L	Ash	n
Bactrian camel	6.67± 2.93	3.33± 0.74	13.07±1.15	2.77 ± 0.96	–	56
Dromedary	5.94 ± 2.26	3.03 ± 0.76	12,39 ± 0.74	3.12 ± 0.92	–	70
Hybrids	6.09 ± 1.81	3.28 ± 1.01	11,91 ± 0.74	3.04 ± 0.60	–	20

FM: fat matter; TP: total protein; DM: dry matter; L: lactose.

According to the data [133] (table 13) in one liter of camel milk, are 150g. dry matter, 50g.fat, 45g.protein, 50g lactose, 7g.minerals (ash) and a lot of vitamins. Energetic value of 1 liter camel milk is 787-911 kcal. Camel milk is known for its richness in vitamin C between three and ten times higher than in cow milk. In consequence, the camel milk has stimulating effects on the human immune system, provides sufficient vitamin C for people living in the desert, and presents normal acidity unfavorable for bacteria growth, allowing milk preservation in the harsh conditions of the arid lands at ambient temperature for several hours [95].

Table 13 - Comparative composition of minerals and vitamins in camel and cow milk.

Milk	Minerals											
	Macroelements, mg%			Microelement, µg%			Vitamins, mg %					
	K	Ca	Na	Fe	Co	Zn	B,	B2	PP	C	A	E
Camel	180	121	70	100	5	400	0,05	0,0	0,09	7,7	0,0	0,13
Cow	148	122	50	67	0,8	457	0,04	0,1	0,10	1,5	0,0	0,09

The “health” factors attributed to camel milk and its processed products could be linked to some of its components: lactoferrin, immunoglobulin, lysozyme, lactoperoxidase, vitamin C. These components are generally present in milk from other species, but in camel milk, they have the particularity of being thermoresistant and sometimes as for lactoferrin or vitamin C in high quantities [96]. Also, camel milk is considered to have antidiabetic properties, anti-cancer and more generally to have dietetic quality, because of its richness in unsaturated fatty acids [97].

Daily yields of 3–10 kg in a lactation period of 12–18 months are common [98]. Milk yield for dromedary for 12 month is 2000 liters. And sometimes up to 3000 liters or more, with a fat content of 4.3%. For Bactrian Camels dairy productivity for 8-12 months of lactation – 1200 - 1250 kg, with fat content not below 5.2% [99]. The more productive dromedary population is widespread in the southern part of Asia and

especially the Turkmen Arvana breed is present in the overlapping zone of both populations on the territory of Kazakhstan. It originated from Turkmenistan, for milk production [100]. Therefore, Kazakh camel breeder can hybridize these species to produce fertile off spring for dairy purposes which would cohabit in the same herd [87, p. 650]. The dairy production by a herd composed by different species raised the question of the differences in milk yield and composition. Generally, Bactrian camels are known to be less productive. A comparison of milk composition between both species in different Kazakh herds [101] showed increased fat and protein content in milk of Bactrian camels in comparison to dromedaries and lower milk density in Bactrians compared to this density in hybrids. Nevertheless, the main product of Kazakh camel breeder is shubat, a fermented product based on the whole milk what make the breeder sensitive to improve especially the milk yield of their animals.

The ways to determine of milk yield of Camels have studied in several publications [102, 96, 103, p 130]. To determine full milk production is not easy in camel as the part of milk has been drunk by the young. Moreover, the young camel is staying with her mother several hours per day and drinks the milk. To determine full milk productivity, the quantity of drinking milk by the young have to be assessed. Several ways to determine full milk production were suggested. According to U. Chomanov to mesure the full production per day, a control milking (1 day per month) must be achieved, then estimate according to the formula:

$$U_s = U_t * 24 / B$$

- U_s – milk production for 1 day (liter);
- U_t – fact liter per day (hour);
- B – time of milking of camels (hour).

Other methods are proposed (Faye, personal communication): (a) to make the total milking of 2 teats and let the other teats for suckling by the young camel: the total production must be multiply to 2. (b) to measure the milk resulting from milking and weight the growth of the young camel: for example, if the young calf is weighing 50 kg at the beginning of the month and 65 kg, 30 days later, the gain was 15 kg, i.e., 500 g/day. To get 500g/day, the camel calf must drink approximately 4 liters/day (on average we estimate that 7-8 liters are necessary for 1kg of growth); (c) to discard the calf, to make the full milking and to give back milk with a bottle to the camel calf.

In accordance with the time, the maximum milk productions camels occur during the first six months of lactation, coinciding with grazing in the spring and summer, and during the early fall. With the deterioration of pastures in late autumn and winter and the onset of cold weather, milk production is reduced. With the advent of spring ephemeral vegetation, milk production increases slightly, and then decreases again due to the deterioration of the grass and foals. The milk yield of camels depends on feeding and. proper organization of grazing and good feeding stall period to dramatically improve the productivity of camels. Camels grazed from April to November, and remain in the stall -from December to March. The basic food of

camel is the natural vegetation of the wilderness and semi-dry food. Because of their ability to choose plants and consume the most nutritious part of the plants, camels in pasture choose themselves the right diet.(Chomanov et al, 2001)

1.9.2 Camel Meat productivity

The Camel meat is well known for its low fat and relatively high polyunsaturated fatty acid content [104].

The meat composition of *C. dromedarius* and *C. bactrianus* presents some differences. Moisture, fat, protein, mineral, saturated and unsaturated fatty acid contents of muscles were significant different in Dromedary and Bactrian camels [85, p. 105]. Bactrian camel muscles contain oleic, linoleic, α -linoleic acid, which have known as high level mono- and polyunsaturated fatty acids [106].

Chebishev (1968) The carcass weight of camels, is on average 56% of live weight of animals. In other source, the carcass weight ranged between 32 and 50 %. The comparative data of the live and carcass weight of Bactrian and Dromedary camels is described in table 14.

Table 14- Meat production of camels (grey – *C. dromedaries* and white – *C. bactrianus*) (Tibary et.al, 1997)

Age and sex of the animal	Live weight (kg)	Carcass weight (kg)	Yield (%)
Male, 2 year (24 month)	337	128	38
Male, 1 year 8 m (20 month)	309	154,1	49,9
Male, 3 year (36 month)	560	224	40
Male, 2 year 8m.(32 month)	466	222,7	47,8
Female, 4 year (48 month)	396	129	32,6
Female, 3 year 8m. (44 month)	537	257	48,8
Female, 5 year (60 month)	407	136	33,4
Female, 4 year 8m.(56 month)	656	287,4	50,8

Nowadays, the use of camel meat does not take up more space in the diet of the all population of the country. Only population of the southern part of the country is camel meat eater. Thte is globally a lack of knowledge about the quality and properties of camel meat. Based on national traditions, and identity of manufacturing of national meat products, S.R.Ospanov and Z.M.Musaev offers the following division of camel meat is available [134] :

- Hump fat (orkesh) and *com-may* (kazi) - deposits of fat on the

- the inner side of the last six ribs on both sides and the peritoneum
- to the white line;
- karta - large intestine, straight intestine.
- Kazy

There is little information about contamination of camel meat. According available data regarding the contamination level of camel by organochlorines in environmental condition the order was following: DDTs > HCHs > lindane > dieldrin > aldrin > endrin > toxaphene > HCB > chlordane. Elsewhere, the most contaminated organs in animals were in order: liver > kidney > muscle [76, p. 160].

1.9.3 Camel wool

The camel wool is heterogeneous and consists of down and awn. In table 15 described the comparative information of wool productivity of Bactrian, Dromedary and hybrid Camels.

Table 15-The comparative data of wool productivity of Camels

	Domedary		Bactrian, Kamyk breed,		Bactrian, Kazakh breed,		Bactrian, Mongol breed,		Hybrid
	Male	Female	Male	Female	Male	Female	Male	Female	female
Wool, kg/year	4- 5.5	2-3.5	12	5.7	10.5- 11.5	5.4-5.7	8.1	5.2	5.3

Camel wool is utilized by camel breeders for the manufacture of items to be used in their own household such as rugs, blankets and saddle girths. In Rajasthan [107] similarly to camel milk, there were earlier certain cultural restrictions on the sale of wool. Because of low wool yields in dromedary and short fibre, there appears to be only limited potential for commercial use of camel wool.

Unfortunately, not clear recent information about export and import of Camel wool of Kazakhstan. According available data Kazakhstan the main Camel hair factory exported 50 tonnes of raw camel in 2000 year [108].

Data on camel wool contamination are not available. However, in a study regarding contamination of dairy cows hair [130, p. 1538], it was reported that the hair contamination was 10 times more than liver and 30 times more than the kidney in pg/mg of fresh weight. It is mean that the organic pollutants such PCBs, could contaminate camel wool, but in our experiment we did not sample wool, because it is not used as food.

1.9.4 The role of the hump

The main adipose tissue of camel is located in the hump [109, 110], after around the kidney (perirenal fat) or viscera. Fat storage can occur on other parts of the carcass (shoulder, sternum, flank, ribs, thigh and neck), and in the rectogenital zone. According to Schmidt Nielsen (1964), the main role of the camel's hump is 'water economy'. The adipose tissue in the hump of that animal can yield an amount of water equal to four times the original mass of fat.

Also, the hump can be the good tool for evaluation of body condition of the camels. For example in body condition score method [110, p. 620] the better indicator of evaluation of body condition of the animals is fat storage rather than the live weight of the animals. If we consider that the camel's hump represent approximately 80% [109, p. 140] of the whole fat, the hump plays importance role for assessment of the camels energy storage.

The humps lipids consist are mainly triglycerides. There is very few information about fatty acid composition of the Bactrian humps. According to the fatty acids composition of dromedary camels [131, 132], the main fatty acid of the hump fat is palmitic (34.4%) followed by oleic (28.2%), myristic (10.3%) and stearic (10.0%).

2 MATERIALS AND METHODS

2.1 Materials

2.1.1 Experimental design

The lactating ruminant may be exposed to POPs, such DDT and PCB when they are eating polluted feed or soil during grazing. According previous published data regarding impact of PCBs-54,-80,-155 and 4,4 DDE in ruminant (sheep) previously contaminated by intramuscular injection at experimental conditions, the toxic equivalent of pollutants (on a fat basis) was approximately 2,5 times higher in milk than in blood. Moreover, studies of the transfer of PCDD/F and PCB to milk in goats exposed to a long-term intake of contaminated hay in experimental condition also shown that the contaminants had rapidly high levels of PCDD/Fs and PCBs in milk after one-week exposure. These studies of kinetics of contamination and decontamination of the animals in order to precise the transfer of pollutants in lactation goats and sheep were investigated in European countries. But researches about transfer of pollutants and mechanism of spread of contaminants in camel organs (hump-fat, blood, milk) were never conducted and the concentration of this pollutant has not been studied in comestible parts of animals. Thus, this work aims to study the entry and distribution of DDT and PCBs in the body of camels, as well as ways of removing these contaminants.

So, our research work aimed to answer to the question like: how are (i) the spread of DDT and PCB in blood, milk and hump fat of Bactrian camel and (ii) behaviors of decontamination of these pollutants. Therefore it is necessary to evaluate and to prevent the transfer of environmental contaminants in these animals in order to minimize the risk of contamination of the produced food

To achieve this goal, the experimental design included 3 main steps:

- Controlled contamination of lactating Bactrian camels by a chronic oral exposure of non toxic doses in order to reach a concentration plateau (steady state) of DDT and PCBs in their tissues (milk, blood and hump tissue);
- Evaluate the carry-over rate of the exposure dose, especially into milk;
- Follow the decontamination kinetics in the animals after the full stop of the exposure of the animals in order to calculate the delay to recover background levels in their tissues.

In the experiment, four lactating Bactrian camels (*Camelus bactrianus*) have been exposed to two types of organic contaminants (DDT and PCB-mixture) during 2 months (56 days contamination period) in order to reach a final concentration plateau in milk, blood and body fat (hump). After this period, the exposure of the animals has been stopped and the decontamination kinetics has been followed up during at least 4 months (120 days decontamination period). Total duration of the trial was 6 months. Samples were taken from milk, hump fat and blood serum of camels and their calves. Moreover, during of experiment, body and hump were measured and evaluated and the milk yield was recorded. At the end of the experiment animals returned to their herd.

2.1.2 Experimental Location

The experiment was achieved in farm “Aigene” located in Sozak region (North part of South Kazakhstan oblast). The center of the region is Village “Sholak-Korgan”. The Aigene is 30 km north from Sholak-Korgan (Figure 8).



Figure 8-Located place of Sozak region

The Sozak region is desert livestock area. According of the nature conditions of this region (table 16) this area is suitable for camels. There are 9 386 Camels [111].

Table 16- Geographical features of the Sozak region

<i>Parameters</i>	<i>Data</i>
Location	South-Kazakhstan oblast
Vegetation type	Steppe, desert and semi-desert zones
Main Plants	<ul style="list-style-type: none"> - <i>Alhagi persarum</i> - Camel thorn or camelthorn; - <i>Haloxylon aphyllum</i>-Haloxylon; - <i>Atriplex altaica</i>; - <i>Zastagzostis splendens</i>; - <i>Artemisia</i>; - <i>Climacoptera lanata</i>; - <i>Bromus inermis</i>; - <i>Salsola arbuscula</i>.
The soil cover	Brown and gray-brown desert soil, sandy soil and ‘takyr’
Temperature Summer:	+35- +40
Winter:	-30- -35
Rainfall	100-150mm/year

2.1.3 Experimental Camels

For experiment, four Lactating *Camelus Bactrianus*, 7-16 years old were chosen. The weight of animals ranged 400 to 520 kg. Before experiment, data about age, calving date, parity were reported (table 17) as well as sex of calves. All Camels have been identified with ear tags. The animals were in healthy conditions all along the monitoring.

Table 17-Age, calving date, parity and live weight of the experimental camels

ID Camels	Age (year)	Calving date	Parity	Live weight (kg)
Camel 1 ID 00	7	28 March	2	400
Camel 2 ID 52	7	30 March	2	410
Camel 3 ID 62	15	25 March	5	520
Camel 4 ID 69	16	3 April	5	455

2.1.4 Contaminants for exposers

Experimental Camels was exposed to DDT (PESTANAL, analytical standard - 31041 Fluka) and PCBs mixture (Aroclor 1254 – catalog n° 4-8586, lot LB89250), what has been introduced in gelatin capsules (length – 2 cm, diameter – 9 mm, weight of empty capsule is 120 mg and weight with icing sugar approximately 300 mg) by hexane solvent, which is absorbed by icing sugar. Two hundred twenty four capsules corresponding to 56 days for 4 camels were prepared in 11.08.2012 in UR AFPA (Nancy, France). The contaminants for one camel was quantified for PCBs 1.3 µg/Kg and DDT 0.2 µg/Kg body weight by day. In one capsule the concentration of PCBs was 0.8 mg and DDT 0.12 mg per camel/day. As each camel received one capsule during 56 days, the total exposure doses of one camel was 44 mg of PCBs and 6.7 mg of DDT. The chemicals have been given to the animals via capsules inside of bread.

In order to reach the concentration plateau more rapidly, a primary dose of 9.13 mg for PCBs and 1.41 mg DDT have been given at the first day of exposure. This dose with PCBs and DDT solution was prepared in oil solvent (Cremophor EL - reference 95921 SUPELCO). The capsules of primary dose were 12 times higher than dose of capsules.

2.1.5 Materials and Equipment for analyses

- Gas chromatograph with mass spectrometric detector Agilent 7890A/5973N.

Dual channel gas chromatographic system. Gas Chromatograph 7890A (Agilent, USA) equipped with two devices for input samples with split / splitless , mass spectrometric detector Agilent 5975C and electron capture detector. Automated high-precision input liquid samples into a gas chromatograph autosampler provides Combi-PAL (CTC Analytics AG, Switzerland), which also allows you to fully automate sample preparation methods of solid-phase microextraction (SPME) and vapor-phase extraction (PFE) .

- Analytical scales, an accuracy 0,0001 g., maximum weight 60g. (Ohaus, China);

- Technical scale, an accuracy 0,01 g., maximum weight 300 g., (Shimadzu, Japan);
- Single-channel compressor, CX- 0078, (Champion, China);
- 6 Port evaporator (USA);
- Vials (2 ml) with inserts (200µl) Agilent (USA);
- Micro Kudrena Danish concentrator, Sighma-Aldrich (USA);
- Micro glass syringes (10 µl, 25 µl, 50 µl, 100 µl), Agilent (Australia);
- Separate funnel - used for milk extraction (250 ml),
- Scalpel, for hump fat
- glasses (50 ml),
- cylinders (5ml, 10ml, 20ml),

2.1.6 Characteristics of Chemicals

The analyzing standards used were:

- 7 key Isomers of PCBs (28, 52, 101, 118, 138, 152, 180) 99,0% of purity, concentration 10 µg/ml – (LGC STANDARD GmbH, lot number: 121313 3, Germany).
- Internal standard PCBs 209 - Decachlorobiphenyl (Sighma-Aldrich, laborchemikalien, GmbH D- 30918, cat number. 31092).

For extraction:

- Hexane – 95%, Sighma-Aldrich (USA);
- Sulphuric acid – 98%, (Russia)

For clean-up:

- Silica gel, particle size 63-200 µm, 70-230 mesh, Sighma-Aldrich (USA);
- Florisil, PF grade, particle size 149-250 µm, 60-100 mesh, Sighma-Aldrich (USA);
- Sodium sulphate 99%, anhydride, granules Sighma-Aldrich (USA)
- Glass wool, Sighma-Aldrich (USA)

For concentration:

- Decan – 99%, Sighma-Aldrich (USA).

2.1.7 Sampling

All samples were taken according to the established agenda. The collected samples were milk, blood serum and hump fat by biopsy. Control samples were collected in first day of experiment before starting the oral exposure period by capsules. The samples have been taken in duplicate, for reserve samples. All sampling tubes were numbered according to ID of camels, date, and reserve or not.

2.1.7.1 Blank samples

For blank samples of milk and serum sample of non experimental Bactrian Camel were used. The milk blank sample was mixed milk of Bactrian, dromedary and hybrid camels taken from Aigene in January 2014, because all camels was in the same pasture and conditions.

Blank fat sample have been taken in slaughtered non-experimental camel in other farm of Sozak region in June 2013.

2.1.7.2 Sampling of milk

Milk samples were collected: one time in adaptation period (initial), two times during contamination and eight times during decontamination period. Total was 11 milk sampling during experiment. Experimental camels weren't accustomed to be milked and 2 ml of oxytocin were inoculated just 2-5 min before milking. Immediately after sampling, milk samples were transferred into 40 mL glass bottles and kept in cold ice box during their transportation to be frozen at -20 °C until analysis.

2.2 Methods

2.2.1 Measurements and estimations

During the experiment, body, hump measurements and estimated milk yield was determined and the milk composition was defined (fat content, dry matter and density) at each sampling date.

2.2.2 Body measurements

The measurements were achieved on standing animals in corridor with a meter-ribbon and reported in cm. On each camel, the following measurements were collected: neck circumference NC (1), body length BL (2), Heart girth HG (3), thigh circumference TC (4), the height of the humps (Front HH1 (5), back HH2 (8)), small (HD1) and large (HD2) diameters of the humps (front (6, 7), back (9, 10)) (figure 11.).

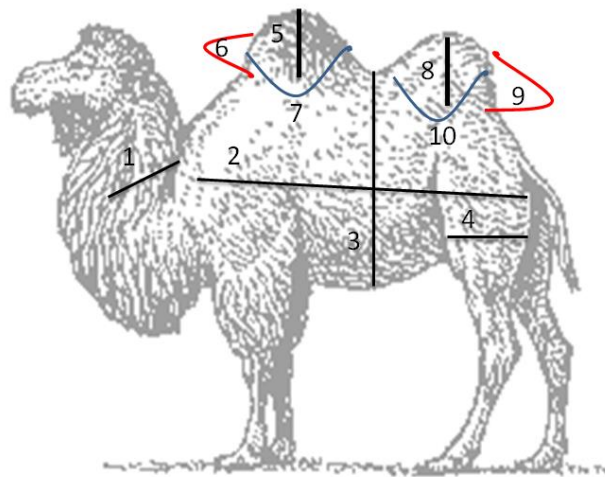


Figure 11- Body measurements in Bactrian Camels

The measurements were achieved on the animal after taking off the wool which could modify the reading of the different distances. Regarding the hump measurements, the reported values (height of the hump HH), small diameter HD1 and

large diameter HD2) were used to assess the volume and the weight of the hump. The animals were weighed at the beginning of the experiment on a scale for trucks.

2.2.2.1 Definition of body weight in the scale

In the adaptation period, the experimental camels were weighted on scale, once time 35 km from the farm Aigene. The weighting was follow: first weighting involved the truck, then after the camels were loaded into the truck and both (truck and camel) were weighted second time. The weight of camel was estimated by difference. The graduation of the scale was 10 kg, precision 1 kg. The maximum level of weight was 10 t.

2.2.2.2 The methods of estimation of body weight

The experiment was in farming condition, where it was not possible to weight the camels on scale. That's why we analyzed several estimations method to determine body weight close to the results of the scale.

For estimation of body weight by barimetric 4 methods were tested: Kamili (2006) [112] , Lakoza and Chekin (1964) [113], Baimuhanov (2009) [89], and Faye model of estimation of body weight, established during the experiment (2013). Few data about estimation of body weight of bactrian camels are available in the literature [114] contrary to dromedary camels (Kamili et al., 2006). Yagil [115] estimated the live weight by using the equation $W=50*HSH*THG*HG$, where W=body weight in kg, HSH=the shoulder height using the measuring stick vertically from the ground to the top of scapula, THG=the thoracic girth using the meter ribbon around the body just behind the sternal pad, and HG=the hump girth using the measuring tape along the abdomen over the midpoint of the hump. But this method did not give convenient result for Bactrian. The four methods tested for our experimental animals were the following:.

Method Lakoza and Chekin. This method was applied during the Soviet Union and was used for Kazakh Bactrian's [116] and Kalmyk Bactrian's [117]. The body weight of camels older than three years was determined by using the table of Chashkina (appendix 1), where body weight was determined by the body length and heart girth . The method must be subtracted: with a good body condition camel - 20 kg, with a poor body condition - 30 kg, and 50 kg for the exhausted animals. Deduction is not possible for determining the weight of young animals (figure 12).

The accuracy of this method has been tested with excel program- version XLSTAT 2010.6.01.. The following equation explainin,g 70% of the variance was determined

$$\text{Equation 1} \quad BW = -795,5 + 3,5 * \text{girth} + 3,75 * \text{length}$$

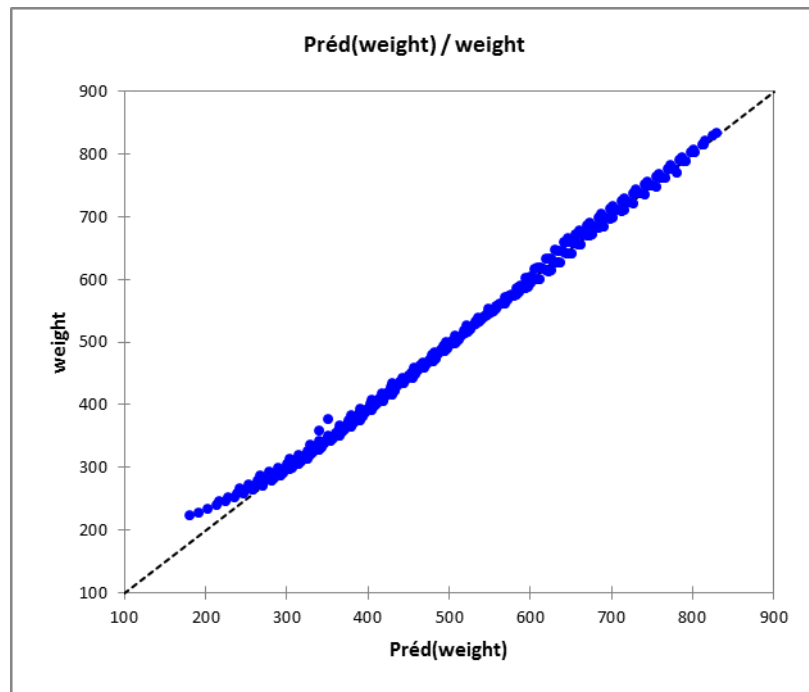


Figure 12- Correlative variation of Lakoza and Chekin method

Method Kamili (2006). This method have been developed and created for the determination of weight of Dromedary in Morocco and according to the model, 5 parameters on standing or sitting animals are necessary to be collected:

- Neck perimeter (TE): level of cervical vertebra C3 and C4;
- Heart girth (TP): circumference of thorax under the sternal cushion and in the middle of the humps;
- Abdomen perimeter (TA): the abdomen circumference passing by the middle of the humps (for dromedary in top the hump);
- Thigh perimeter (PC): circumference at the middle of thigh;
- Sizes of humps: we will take measurements separately for each hump:

The length (LB) measured between the cranial and caudal limit passing by the base of the hump; the height (HB) measured between the base (coastal limit) and the top of the hump;

Neck perimeter and thigh circumference appeared the best predictors of the carcass and live weight. The following equation was applied:

Equation 2:

$$\text{Body weight (kg)} = 4,06 \times \text{Age (year)} + 3,05 \times \text{neck perimeter (cm)} + 3,38 \times \text{thigh perimeter (cm)} + 2(1,38 \times \text{hump length (cm)}) - 191$$

Method Baimukhanov (2009). This method consists to multiply the heart girth and body length and divided by a age coefficient, which based on individual weighting of animals at birth and 1,2,3,6,12,18,36,48 months, then adult period (table 21).

Table 18-The age coefficient of camels for estimating body weight

Age	Bactrian		Dromedary	
	female	male	female	male
In birth	150	150	140	140
1 month	110	110	120	120
2months	105	105	110	110
3 months	100	100	105	105
6 – 11 months	95	95	100	100
12 - 17 month	90	90	95	95
18 - 23 month	80	70	75	70
24 - 35 months	75	65	70	67
36 - 47 months	70	60	68	65
48 - 60 months	67	55	65	63
Adult (5 year and more)	64	52	63	62

The main equation for this calculation is described below:

Equation 3:

$$BW = \frac{HG * BL}{CA}$$

Where: BW - Body Weight; HG - Heart girth; BL - Body length, CA – Coefficient of age

Method Faye (2013). This method was developed during the experiment. With the available data, the body length appeared the most correlated with the body weight ($r=0.925$; $P=0.075$), but due to the few numbers of animals, the statistical power is not sufficient to reach significant level. By using stepwise linear regression model, only body length could predict the weight with a good accuracy (table 2). The equation of prediction was:

Equation 4:

Body weight = -838.6 +9.01 Body Length (SE= 0.265)
--

The comparative data table of estimation of body weight of Bactrian Camels by these 4 barimetric methods is reported in table 19. Among these four methods to estimate the body weight of our experimental camels, it appears that the method of Faye (2013) was the most convenient, the data of this model being closer to the data of scale.

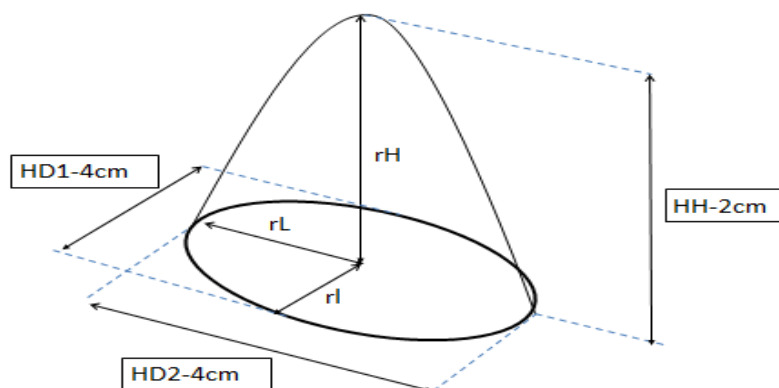
Table 19-Body weight and prediction of the weight by models

Observation	Body weight on scale (kg)	Lakoza and Chekin (1964)	Kamili (2006)	Baimukhanov (2009)	Model Faye (2013)
1	2	3	4	5	6
Camel 00	400	538	377.24	490	423,9
Camel 52	410	499	445.72	493	387,9
Camel 62	530	593	678.78	544	514,1
Camel 69	455	579	701.05	553	469,0

2.2.2.3 Hump measurements

The hump shape was approximately regarded as a cone with ovoid base and the volume could be assessed by the formula:

$$V=1/2 (4/3\pi*r_l*r_L*r_H) \text{ (figure 11)}$$



Where r_l =small circle radius of the cone's base (here HD1/2)
 r_L = large circle radius of the cone's base (here HD2/2)
 r_H = height of the cone (here HH)

Figure 13-Representation of the hump shape for assessing volume and weight

In order to take in account the skin sickness, the values HD1 and HD2 were reduced by 4cm (2 x2cm) and the value HH by 2 cm.

The weight of the hump was estimated by considering the fat density which is 0.84 [112, p. 68].

2.2.3 The estimation of milk yield

Milk yield and composition have been determined by injecting 2 ml of oxytocin. Because, the experimental camels never milked before, they were wild. Camel 62 was particularly difficult because even with oxytocin

injection, no milking was possible and the camel comes down. That is why the milk yield for camel 62 should not be considered.

The yielded milk of the four milked teats were measured in a graduated measuring cup, the recorded yield was multiplied by two in order to estimate the milk yield of 24h. In consequence, for estimation, we used next equation:

$$\text{Milk yield (24 h)} = X * 2$$

2.2.3.1 The calculations of carry-over rate in milk

Carry – Over Rate was used as an ideal parameter to describe contaminant transfer to lactating animals [118]. COR was calculated when steady state was reached as follow:

$$COR\% = \frac{m * fy}{f * F} * 100$$

Where: m – the concentration of pollutants in milk;

fy – milk yield;

f – the concentration of pollutant in the capsule;

F – daily intake amount of pollutant.

2.2.3.2 Statistical analysis

In order to assess the time effect and the camel effect, a one-way variance analysis (ANOVA) was applied on data from each matrix (blood, milk and fat). The qualitative parameters tested were the camels (4 levels), the number of sampling time (8 for fat and 11 for milk and blood) and the number of periods (3 periods: contamination, first part decontamination, 2nd part of contamination). The data were analyzed with ANOVA procedure using XLstat software (Addinsoft ©)

2.2.3.2 Definition of milk yield and composition of milk

Milk yield and composition have been determined at each sampling date in the morning. The yielded milk of the four milked teats were measured in a graduated measuring cup and this morning milking has been multiplied by two in order to estimate the milk yield of 24h. As experimental camels were not accustomed to be milked a dose of oxytocin was injected according to the body weight of the animal. The yielded milk was gently homogenized and a sample was taken in order to determine the contents of fat (FC), fat free dry matter (FFDM) and the density of milk (De) using a mid-infrared spectrophotometer equipment (Lactan 1-4 MINI©, Sibagropribor, Krasnoobsk, Russia) [figure 12]. The total DM of milk was calculated by the sum of fat content and FFDM, and the fat yield corresponded to the multiplication of fat content by the milk quantity.

2.2.4 Sampling of blood serum

Blood was collected from the mammary vein: one time in adaptation period (initial), two times during contamination and eight times during decontamination period (total 11 blood samples). Sampling was achieved with dry tubes (tubes - 10

ml: 16*100; multiple sample needle – 21G*1 1\2,0,8*38mm). In order to extract serum, the tubes were kept during 3-4h + 20°C (room temperature) and kept in cold ice box during their transportation to the laboratory, where the tubes were centrifuged for 30 min at 1500 min⁻¹ and the serum separated to other tube. From 10 ml blood we took approximately 4 ml serum. The serum was frozen immediately and stored at -18°C until analysis.

2.2.5 Biopsy of hump tissue

Hump fat samples collected using biopsy technique: one time in adaptation period (initial), three times during contamination and four times during de-contamination period. For biopsy, we used the following materials (figure 13):

1. Plier for suture's needle
2. Plier with flat extremity
3. Canula with its trocar
4. Blade
5. Needle and catgut for suturing the incision
6. Syringe for local anesthesia
7. Local anesthesia
8. Other material: cotton, iodine, alcohol and if any sedative



Figure 14-The biopsy materials

As the whole, eight hump fat sampling were achieved during experiment. The animals were tranquilized with IM injection of sedative (Seton 2% ©, 20mg Xylazine in solution) to facilitate the contention. The animals were wild. Therefore, they have been fixed in a barn before manipulation and the quantity injected was 4 ml in spite of lower weight. After ten minutes, the sedative showed the effect on the animal. Then, the place of biopsy on the hump was widely shaved and the skin was disinfected with iodine solution. Around the place of biopsy, local anesthesia was achieved by subcutaneous injection of 10cc xylocaine solution (bomacaine ©) in 5-6 different places “in crown” around the place where incision was projected to be done.

A small incision of the skin was achieved (no more than 1cm large) approximately at the middle of the side of the hump (left or right is without importance). Then, the trocar was introduced through the wound straight in the fat of the hump (only the cannula without the trocar) (figures 15, 16).



Figure 15- The turning of cannula



Figure 16-Cannula inside of hump

The cannula was turned in the hump fat during the progressive introduction in order to cut the fat and to get a cylindrical piece of hump tissue. The cannula was withdrawn and the fat was collected with Luer spoon (diameter 12mm*17mm). For each coring, approximately 0.5 to 1g of fat could be collected. Then one suture was done using ½ circle surgical needle (big size for large animals). Two or three points of suture were sufficient, more if the incision is longer than 1 cm. After suture, the wound was disinfected with blue spray (Chinoseptan ® Blue Spray). The camel remained quiet for 3 to 4 hours but can stand up as soon as the biopsy was finished or return to his box or go to steppe.

2.2.6 Analyzes

2.2.6.1 Method of GH- MS

Analytical works have been done in CPHMA (The Center of Physico-Chemical methods of analysis, Laboratory of Ecology of the Biosphere) where GH-Agilent with mass spectrometric and flame ionization detection Agilent 6890N / 5973N, equipped with a system of pre-concentration of liquid and solid samples Agilent-Velocity XPT were used.

Milk and serum of blood samples were analyzed using a liquid-liquid and fat using solid extraction followed by cleanup on a multi-layer silica gel column, evaporative concentration to 20 µL and analysis on 7890A/5975C TAD TVL GC-MS (Agilent, USA) equipped with Combi-PAL autosampler (CTC Analytics AG, Switzerland). Two µL of sample was injected to split/splitless inlet heated to 250⁰C in splitless mode. Separation was done on a DB-5MS 60 m x 0.25 mm, 0.25 µm film column (Agilent, USA) at a constant flow of helium (purity 99.995%, Orenburg-Tehgas, Russia) equal to 1 mL/min. Detection was done in selected ion monitoring mode (SIM) using 6-group program for detection of target ions. PCB209 was used as internal standard spiked to samples in amount of 300 pg (table 20).

For the reliability, the analyses were carried out with the pure hexane solvent, in order to confirm the absence of analytes and to remove interfering components from the previous analyzes in chromatography.

Table 20- List of organic pollutants detected in SIM mode

Name of pollutant	Number of Cl	m/z	Retention time, min
PCBs 28	3	256	34.64
PCBB 52	4	292	37. 214
PCBs 101	5	326	45. 28
PCBs 118	5	326	53.47
PCBs 138	6	360	56.13
PCBs 152	6	360	59.19
PCBs 180	7	396	66.08
PCBs 209 (internal standard)	10	498	78
DDT	3	235	58.25
DDE	2	318	48.9

The retention time was optimized for the determination of these organic contaminants in biological samples.

To make analysis of contaminants with the chromatographic column, it is not desirable to accumulate impurities interfering components in it. For this issue, glass liner has been used allowing prevent non-volatile compounds in the capillary column.

For the construction of calibration curves:

- A standard solutions was prepared for PCBs with 6 concentrations 1, 5, 10, 25, 50, 100 µg/L with certified mixtures of PCBs (Gravimetric Certificate Seven Key Isomers with 99% of purity (7 components), NE-N 08 13-10, LGC standards)-concentration 10 µg/ml. In each standard solution 20 ml of internal standard PCB 209 were added with concentration 0.5 µL/ml.

A standard solutions for DDT and DDE was prepared with 8 concentrations 1, 5, 10, 25, 50, 100, 250 and 500µg/L in 1 ml with standard DDT (Lazerat) at concentration 100 mg/L.

Prepared samples were analyzed in 2 parallels by gas chromatography with mass spectrometric detection. The data of calibration dependence is described in table 21.

Table 21- Data of calibration dependence

Pollutants	Concentration range, µg/L	Straight line equation	Factor approximation
PCB28	1-100	$y=0.2576x$	0.9922
PCB52	1-100	$y=0.1835x$	0.9973
PCB101	1-100	$y=0.1678x$	0.9948
PCB118	1-100	$y=0.1847x$	0.9948

Continuation of table 21

PCB138	1-100	$y=0.1525x$	0.9956
PCB153	1-100	$y=0.1364x$	0.9936
PCB180	1-100	$y=0.1079x$	0.9968
DDT	1-500	$y=0.1718x$	0.8986
DDE	1-500	$y=0.0832x$	0.895

The calibration dependence of the peak area of PCB 52/101/153 on its concentration in hexane is shown in figures 17.

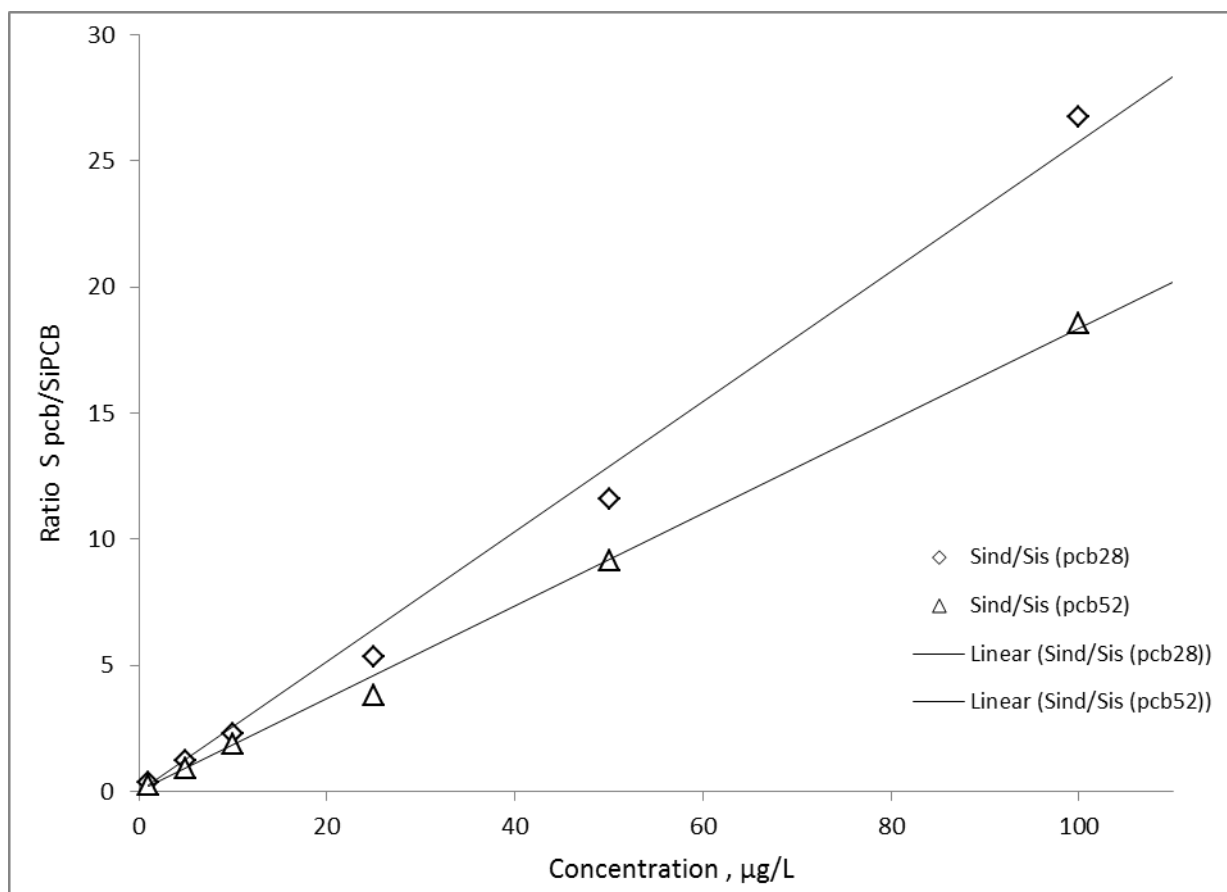


Figure 17- The calibration dependence of the peak area of PCB 52/101/153 on its concentration

2.2.6.2 The calculation of recoverability of pollutants

At first, the dependencies of the peak area of the mass introduced into the column standard iPCB and DDT was analyzed with concentration 1000µg/L in 1 ml quantity with 0.5µg/ml internal standard PCB 209. Then after blank (pure) samples (milk, fat and blood) were analyzed by adding the same concentration of iPCB and DDT pollutants with tissues. Integrated peaks and calculated

Analyzes of standard solution iPCB and DDT with concentration 1000µg/L in 1 ml quantity

Recoverability calculation of by dividing the mass of PCBs, caught in the desorption column, the masses of PCBs contained in the standard solution and multiply by 100%

2.2.7 Control analyzes of milk sample

To check the results of the used method in Laboratory of Ecology of Biosphere (Almaty analyzes of milk sample (reserve) of Camel 52 in other laboratory - CARSO (Lyon)) have been achieved with other method (MET038).

For food samples, methods of analysis are consistent with the criteria set out in Regulation (EU) No 589/2014 of the Committee on 2 June 2014 (food). Method Measuring instrument HRGC / HRMS was used. The final volume was at concentration 25-50 μL and the injected volume from 1 to 3 μL . Analyzes of NDL PCB 118 and iPCBs 28,25,101,138,153,180 in ng of gram of milk have been achieved.

2.2.8 Sample preparation

Sample preparation was based on the method of Klisenko (Methods for determination of trace amounts of pesticides in food, feed and the environment, 1992) and optimized to get more recovery in samples milk, blood and fat. All samples of milk have been in freezer (-22°C) until analyzes.

2.2.8.1 Milk extraction

For the extraction of DDT/PCB analytes from camel milk, 5 mL of sample was put into reparatory funnel and spiked by 20 μL of internal standard PCB 209 ($0.5\text{ }\mu\text{g} / \text{ml}$) and shake for 3 min manually. Then, 5 ml of 98% sulfuric acid were added for fat denaturation. The content of the funnel cooled by cold running water, was shaken vigorously for 5 - 7min. Samples was extracted by 2 portions of n-hexane – 10 and 15 ml respectively. Separate organic (hexane layer) phase was collected and used for further step (figure 18).

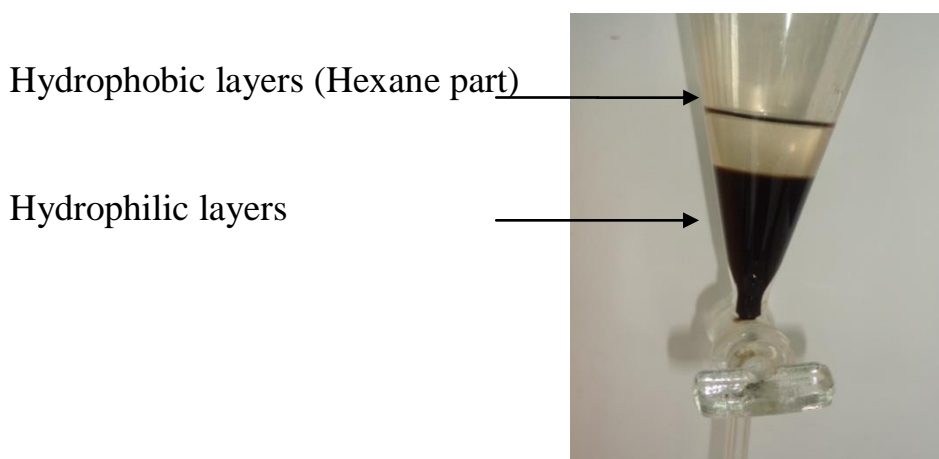


Figure 18- Extraction of Camel milk. Separation of the hydrophilic and hydrophobic layers

2.2.8.2 Extraction of hump tissue

The hump fat was milled with a scalpel in a porcelain mortar. Then 0.5 g were measured and thoroughly triturated with 2 gr. of anhydrous sodium sulfate and dried out to be accessible to a lipophilic organic solvent (figure 19). Then, resulting mass was putted into a conical flask of 100 ml. The porcelain mortar was washed with 2 ml hexane two times. Samples was extracted with 10 ml of n-hexane and vigorously shaken for 30 min. The internal standard was added in extract after shaking in 20 μ l PCB 209 (0.5 μ g / ml) volume. After, it was shaken for 5 min and used for clean-up step.



Figure 19-Milling of hump fat with sodium sulfate

2.2.8.3 Extraction of blood serum

Two ml of blood serum was measured in cylinder and transferred to separatory funnel, then internal standard of 20 μ l PCB 209 (0.5 μ g / ml) was added. Thenafter, samples were extracted with 2 portions of n-hexane - 5 ml and 5 ml respectively and shaken for 10 minutes (figure 20). If was a stable emulsion, to be more clear layer, added to separatory funnel 0.5 ml of 90% ethanol. The hydrophobic layer (hexane layer) was collected in one glass and used for purification.



Figure 20-Separation of hydrophobic layer of serum blood

2.2.8.4 Purification

To clean the extract from matrix interferences, the silica based column was used. The column was filled using the following material (figure 21): glass wool , 2 g Florisil , 1.5 g Silica gel, 4 g mixture of 44% H_2SO_4 and silica, 2g mixture of 22 % H_2SO_4 and silica gel, 2 g Silica gel, 3 g Na_2SO_4 . Before using, the column was activated with 5 ml of n-hexane , then 25 ml of extract was put. After complete elution of the extract, the column was washed with more than 35 ml of hexane. Assembled extract (≈ 50 ml) was sent to the concentration.

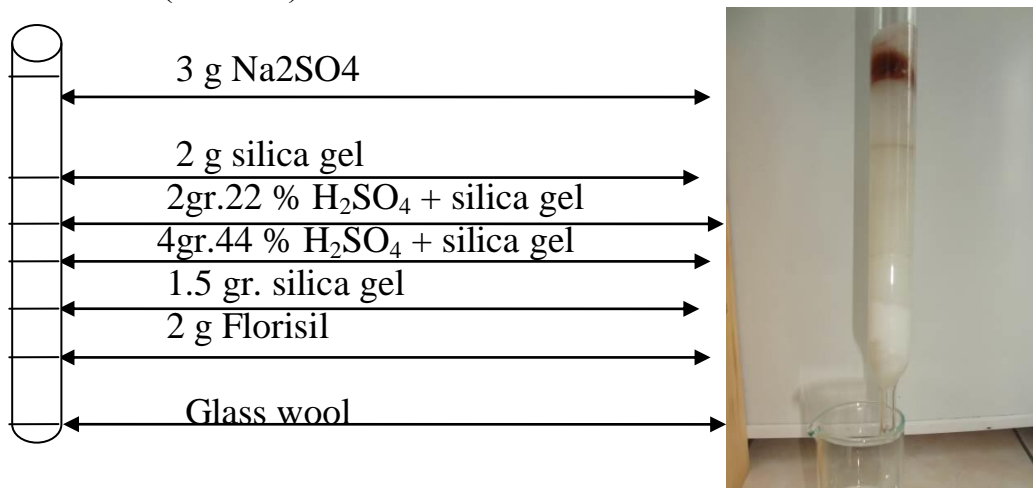


Figure 21-Content of column

2.2.8.5 Concentration

Concentration consisted of 2 stages. The extract primarily pre-concentrated by Micro-concentrator Kuderna-Danish up to 500 μl during the 40 min (Figure 9). Then, the extract transferred partially into 100 μl vials with inserts, in which 20 μl of n-decane was added previously. Addition of n-decane allowed controlling the final volume of the extract. Evaporation was made in a stream of air (figure 22).

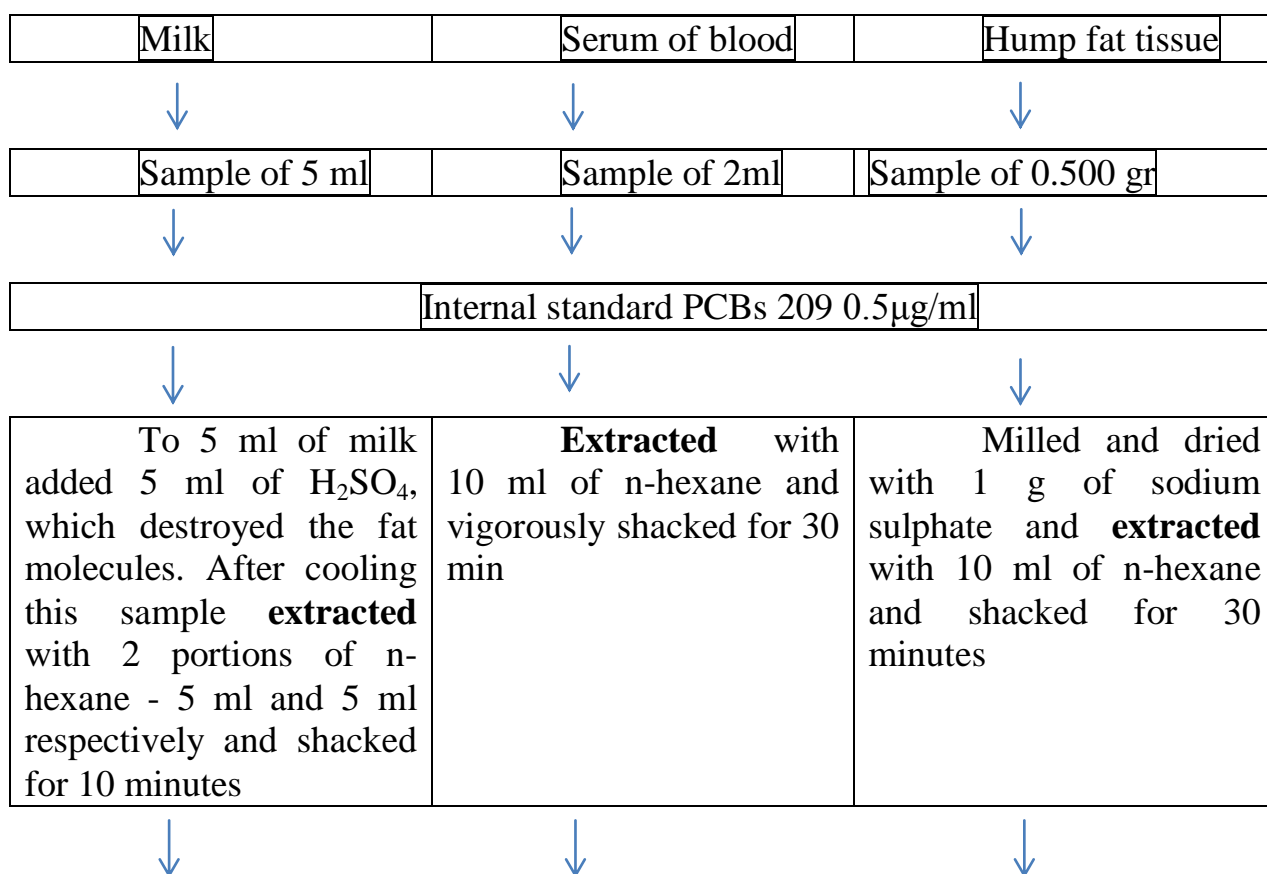


Figure 22-Micro concentrator Kuderna-Danish



Figure 23-Concentration in slow air stream

The general scheme of sample preparation is shown in figure 24.



The column of **purification** filled with glass wool, 2 g Florisil , 1.5 g Silica gel, 4 g mixture of 44% H₂SO₄ and silica, 2g mixture of 22 % H₂SO₄ and silica gel, 2 g Silica gel, 3 g Na₂SO₄.



Concentration up 20 µl of n-decane with Micro-concentrator Kuderna-Danish after vaporation in a stream of air

Figure 24 – The main way of the sample preparation

2.2.9 Calculations

1. Concentrations:

The calculation of concentrations in milk, serum of blood and hump tissue were carried out as follows: calculated the ratio of peak area of indicator PCB and peak area of internal standard and multiplied to the calibration of coefficient. Obtained figures were multiplied to final volume of extract after concentration, because the extractant was concentrated up to 20 µL. Then this data divided to the quantity of sample has been taken for analysis. The used equation was :

- For calculation of concentration in milk:

$$\blacksquare \text{ Concentration in milk} = S_{\text{iPCB}}/S_{\text{is}}*k)*20/5 = X \text{ ng/ml}$$

Where: S_{iPCB} – the peak area of pollutants; S_{is} - peak area of internal standard; k – calibration coefficient; 20 – is concentrated amount of extractant; 5 – amount of milk for analyzes in ml.

- For calculation of concentration in serum:

-

$$\text{Concentration in serum: } (S_{\text{iPCB}}/S_{\text{inter.stan}}*k*\text{calib.coef})*20/2 = X \text{ ng/ml}$$

-

Where: S_{iPCB} – the peak area of pollutants; S is - peak area of internal standard; k – calibration coefficient; 20 – is concentrated amount of extractant; 2 – amount of serum for analyzes in ml.

- For calculation of concentration in hump tissue:

-

$$\text{Concentration in hump tissie: } (S_{\text{iPCB}}/S_{\text{inter.stan}}*k*\text{calib.coef})*20/0,5 = X \text{ ng/gr}$$

-

Where: S_{iPCB} – the peak area of pollutants; S is - peak area of internal standard; k – calibration coefficient; 20 – is concentrated amount of extractant; 0.5 – weight of fat for analyzes in gramm.

2. Amounts:

The calculation of quantity of pollutants in milk was carried out by multiplying the concentration of PCBs to the yielded milk of each sampling day. The calculation equation was:

$$\text{Amount of pollutant} = \text{concentration of pollutants} * \text{milk yield} = X \text{ L/day}$$

According to the data [130] the blood serum is 2% of the body weight of cows. This percentage could be retained for camels, as no specific data is available. Consequently, the calculation of amount PCB in serum was as follows:

$$\text{Amount of pollutant} = \text{concentration of pollutants} * \text{BW} * 0,02 = \text{ng X}$$

Where: BW – body weight of camel; 0.02- the percentage of blood serum of blood

The quantity of pollutants of hump tissue was estimated by multiplying the concentration of hump to the estimated weight of humps:

$$\text{Amount of pollutant} = \text{concentration pollutants} * \text{hump weight} = X \text{ g}$$

3. The calculation of congener percentage composition of Aroclor 1254

For calculation of Carry over rate in milk of mixture Aroclor 1254, first concentration in capsules was calculated. For that, literature synthesis of composition of Aroclor 1254 have been done [119, 120]. The comparatively Aroclor 1254 composition is described (table 22):

Table 22-The percentage content of Aroclor 1254

The percentage content of PCBs congeners in Aroclor mixture 1254						
PCB	Kodavanti et al. 2001		Frame et al. (1996) Lot G4 Aroclor 1254	Frame et al. (1996) Lot A4 Aroclor 1254	Mean	SD
28	0	0	0,19	0,06	0,06	0,11
52	3,55	0,7	5,38	0,83	3,21	2,36
101	7,33	5,56	8,02	5,49	6,97	1,27
118	12,88	11,17	13,59	7,35	12,55	1,24
138	5,95	6,47	5,8	5,95	6,07	0,35
153	3,22	3,06	3,77	3,29	3,35	0,37
180	0,53	0,41	0,67	0,42	0,54	0,13

3 RESULTS AND DISCUSSIONS

It is recalled here that the 3 steps of the research are: (1) contamination of the animals, (2) the determination of the POPs concentration in the different compartment (blood, fat and milk), and (3) the decontamination process. Regarding the first step, it is necessary to assess the importance of the different compartment: (1.1) weight of the animal, (1.2) weight of the hump as main fat storage, (1.3) milk production (notably its fat content). Regarding the second and the third steps, the changes of the POPS concentrations during contamination and decontamination stage are assessed in the different compartments.

3.1 Assessment of the different compartment of the body camels

3.1.1 Body measurements and assessment of bodyweight

On average, the body length was 160 ± 8.3 cm, the heart girth 219 ± 8.1 cm, the thigh circumference 92 ± 4.0 cm and the neck circumference 85 ± 9.9 cm. These values were higher to those reported on Bactrian camels in India [121]: 129.5 ± 2.0 for body length, 210.8 ± 2.9 for heart girth and 81.3 ± 1.04 for neck circumference. Therefore, Kazakh Bactrian camels appeared to have higher size than those Indian breeds.

The changes of the different dimensions along the lactation were not significant (figure 25), but a slight increase of the body length was observed and a transitory decrease of the heart girth at summer time.

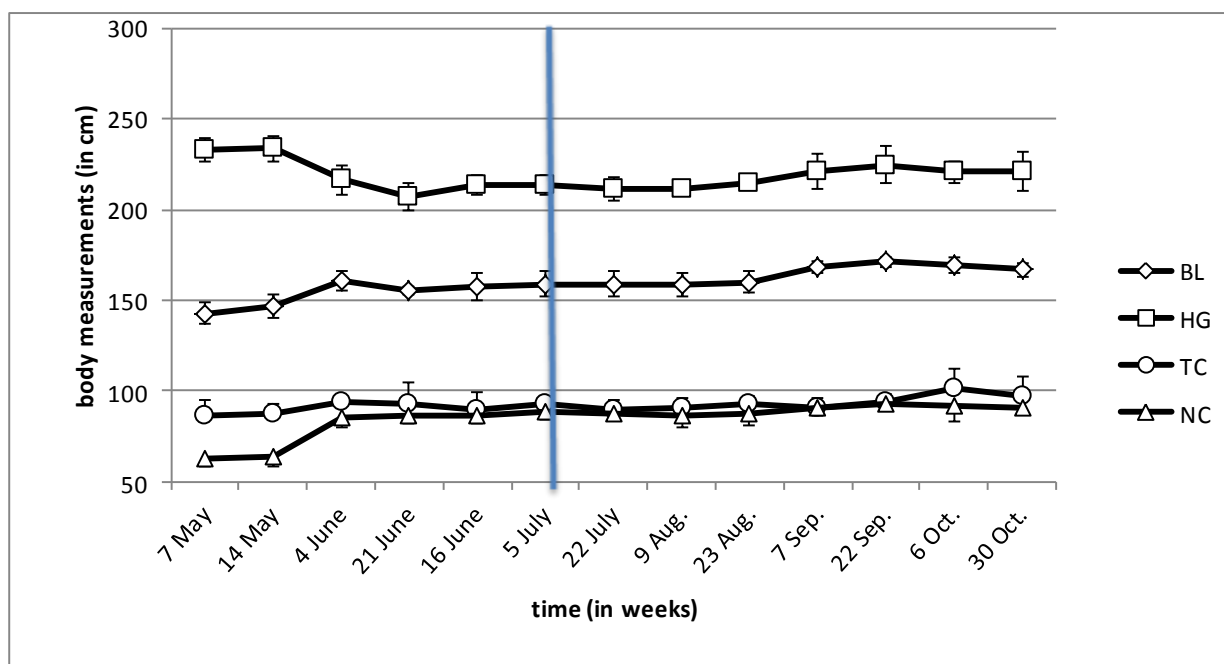


Figure 25- Mean time changes of the different dimensions of the body (body length, heart girth, thigh circumference, neck circumference) of 4 Bactrian camels from May to October.

These changes were observed in all the camels. The animals being submitted to the same environment (feeding, practices, climate), the slight

observed variations were due to the physiological stage and the resources availability. This period of the year is corresponding to the beginning of the hot season, to the decrease of the nutritive value of the natural resources, and the peak of lactation. In consequence, the camels must mobilize their fat storage [122], mainly accumulated in their humps but also partly under the skin above the ribs contributing to reduce the heart girth measurement [121, p. 70].

These results let us suppose the impact of fat mobilization on the only heart girth, the other body measurements being not linked to the change in body condition score, namely the body length, the thigh and neck circumferences. Those 3 parameters are linked to the size of the animals rather to its fattening status.

According to the estimation model, the body weight of experimental camels ranged between 513 and 680 kg over the 6 month. The mean weight of animals was 601 kg (figure 26).

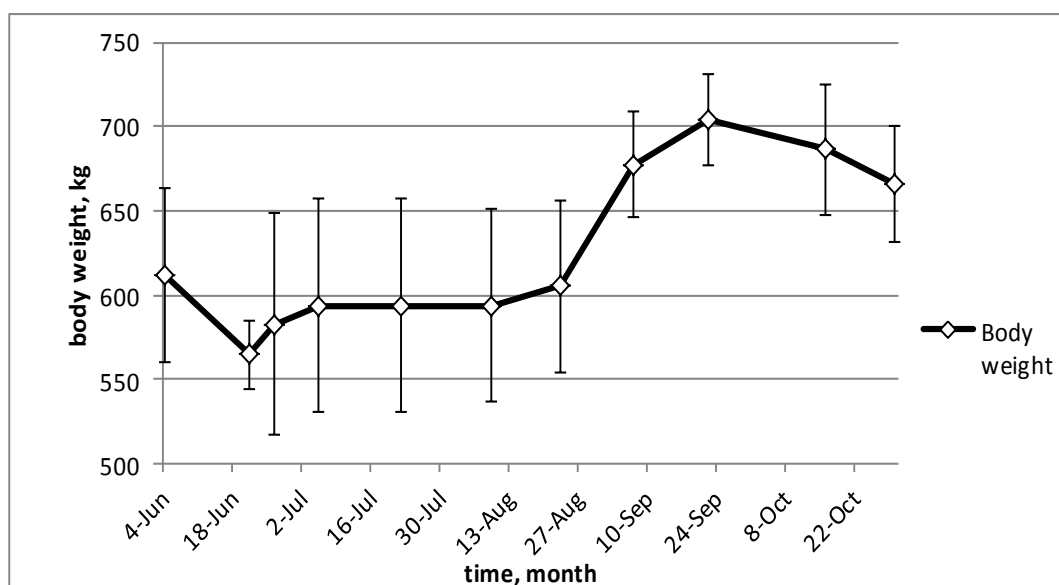


Figure 26-The body weight of experimental camels

Generally all camels were heavier at the end of the trial (last 2 months). Decrease of Body weight during contamination period is not systematic for four camels (figure 24). In the first two months of decontamination period, the weight increased and, near to the end of the trial, was more stable (figure 24).

3.1.2 Assessment of fat storage in humps

In the contamination period the estimated humps weight decreased (figure 27). In the first two month of decontamination period the hump weights increased and at the end of the trial camels slightly become fatter, likely in preparation for winter.

The humps weight ranged between 5.3 kg (Camel OO) and 21.5 kg (Camel 69). The camel 69 was the more fatty camel all over the trial with average hump weight of 17.5 kg. In intermediate group, were camels 52 and 62 with hump weights between 10 and 15 kg. Even though camel 62 belongs to this intermediate group, it was

slightly heavier than the camel 52 at the beginning and the end of the experiment. This could be linked to the age: camel 62 is older than camel 52. The humps of camel OO were lightest with average weight of 6.5 kg for the 2 humps (figure 27).

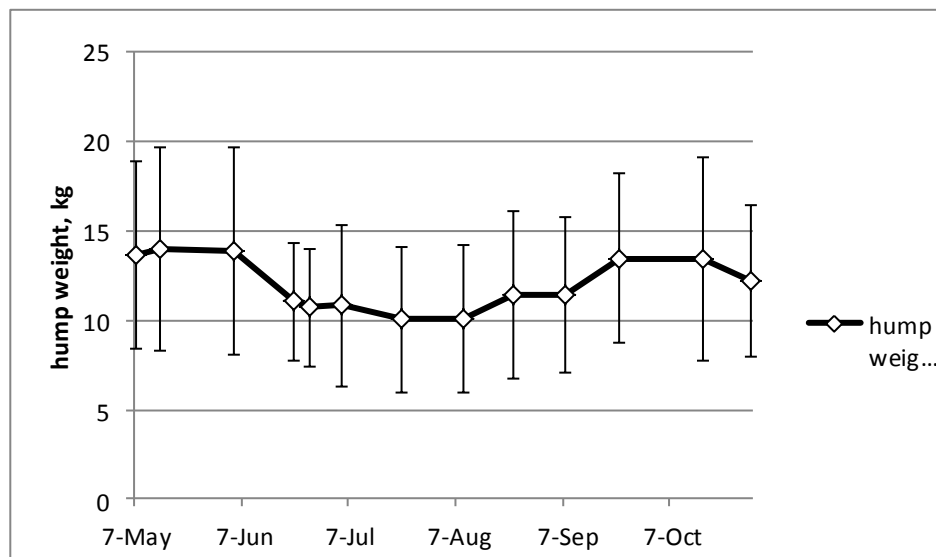


Figure 27-The humps weight of camels during the experiment

According to the results of our experiment the mean data of body and humps weight of experimental camels were correlated (coefficient = 0.8)(figure 28).

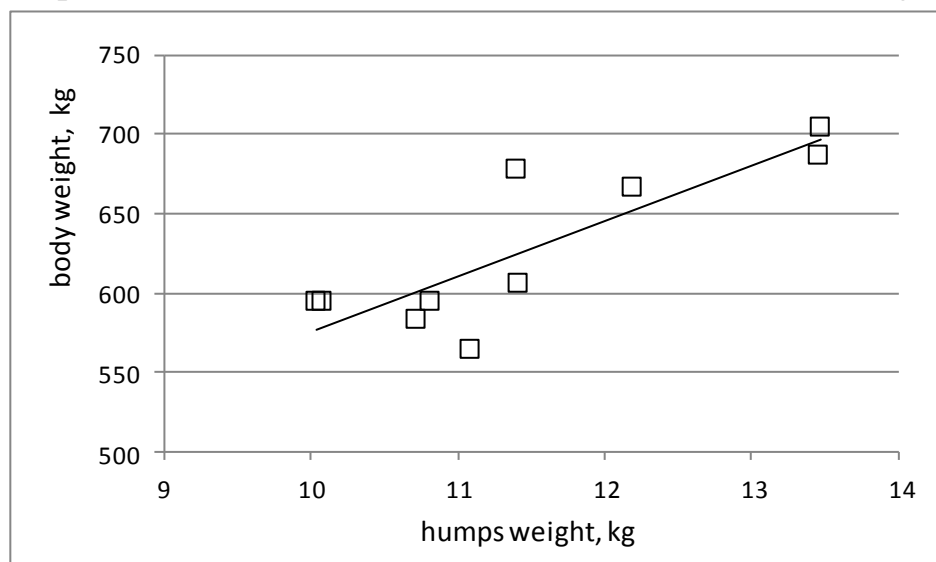


Figure 28-The ratio between body weights and hump weight

3.1.3 Assessment of milk production and composition

The milk yield ranged between 1.5 to 5.5 liters per day for all camels.

The Camel 62 had problems of milking and the milk yield for this camel was 2.8 liters in maximum level but milk should not be considered. Beside this camel, between time-point variations seems quite stable except a peak for camels OO and 52 right on the beginning of the trial.

Between the three other camels, camel 69 was the most productive (on average 3,9 L/d) and camel 52 was the less productive yielding only 2,6 L/d on average.

Camel OO started with high yield (4L/d in May) to fall to 1,5L after contamination full stop and then raised again at the end of the trial to around 3L/d. The mean milk production of experimental camels has been shown in figure 29.

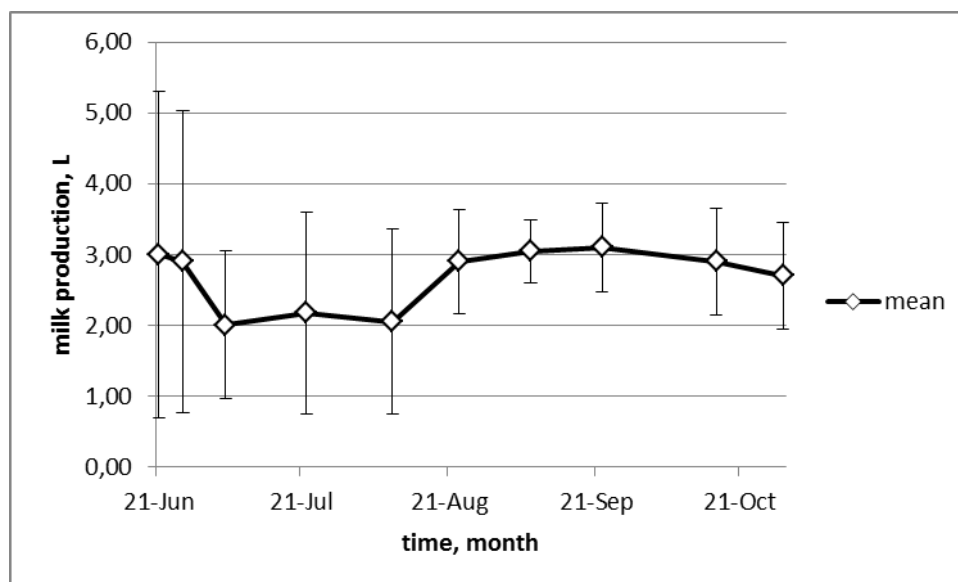


Figure 29- The mean milk production of experimental Camels

The low milk production in July and August can be corresponding to the low nutritional value of the pasture in hot season.

Sampled milk of experimental camels was analyzed for fat content, solid non fat and density parameters.

The value of fat content in milk ranged between 4.0 to 9.5 g/L (mean 6.2 g/L, figure 30). The milk was slightly fatter at the middle of contamination period (plus 2%) and a second stronger increase of fat content (+3 to 4%) has been observed at the end of the decontamination period. In the middle of the trial fat content was low.

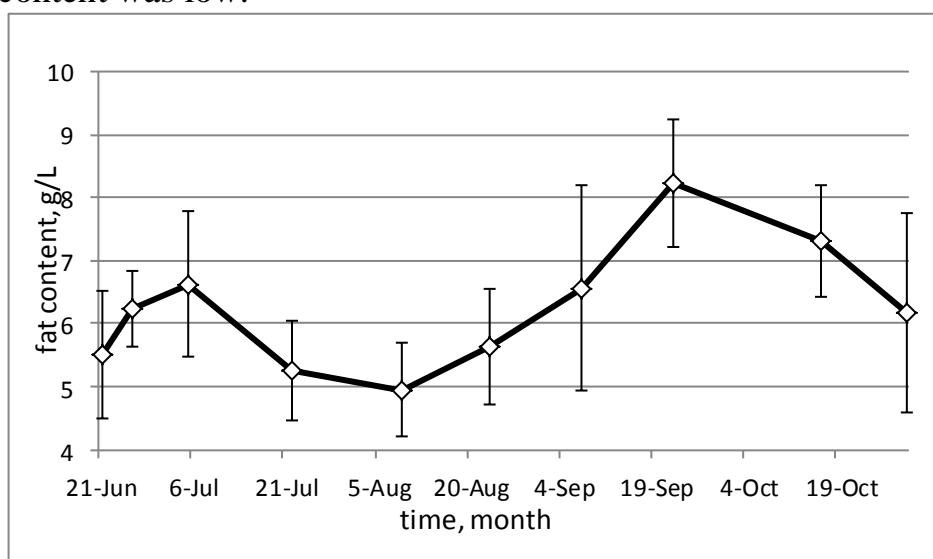


Figure 30-The mean fat content of experimental Camels

According to the literature [123] the fat content of camel milk decreased regularly all along the year with a maximum level in January and a minimum at the summer time (in the hot month). At autumn, corresponding to colder time and to the end of lactation, the fat content increased again to reach similar value than approximately in February. During our trial hot months were July and August, which corresponded to the low fat content of the milk (figure 31). In the middle of September and start of October, the fat content increased for all camels. This data corresponded to the study of Ruchkina (2008) where author noted that in the second month of lactation the fat content decreases slightly, and then starts to increase gradually

However, surprisingly, fat content decreased close to winter which can be link to total milk yield of camels.

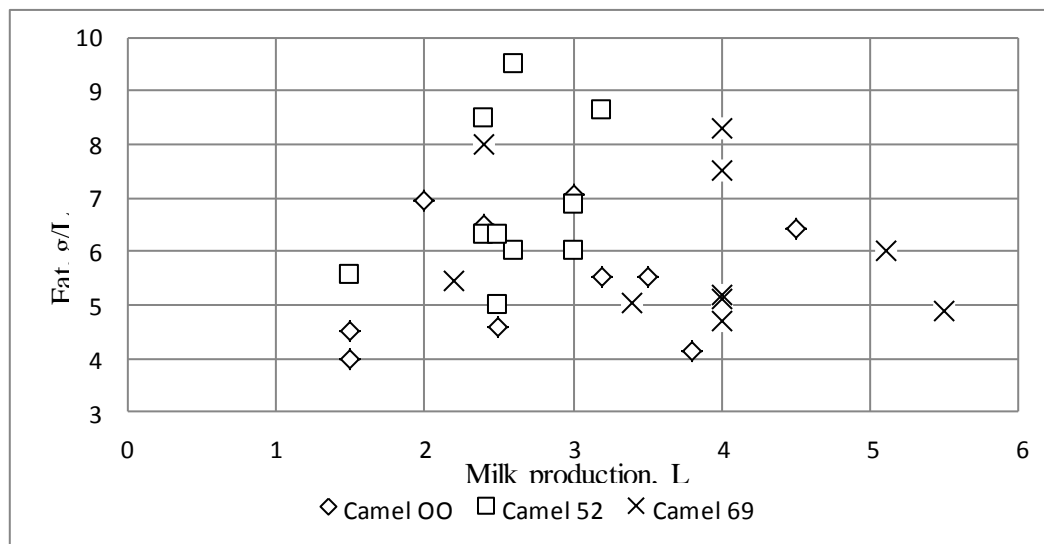


Figure 31-Relationship between milk yield and fat content

The ratio between milk yield and fat content at the different sampling points is shown in figure 32. The milk yield of Camel 69 was higher than in other camels, leading to lower content by dilution effect. The camels OO and 52 were in intermediate group with an average yield of milk, what corresponding with average value for fat content.

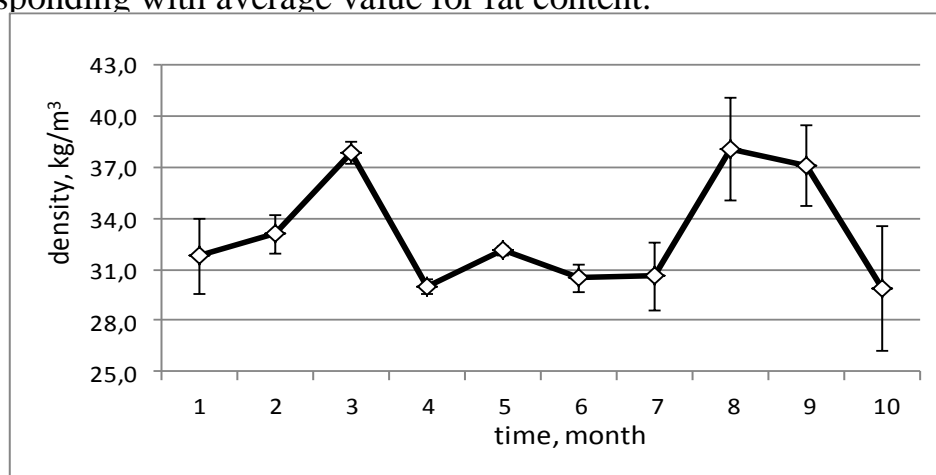


Figure 32-Milk Density of experimental Camels

Density of milk was similar for the 4 camels: increase in contamination period (around 37.5 g/L) and decrease in the first month of decontamination period up to minimum level. After that an increasing in the last 2 months of the decontamination period was observed: Camel 52 showed slightly higher value (41.2 g/L) in third month of decontamination and came down (35.3 g/L) (figure30).

It was observed a time correlation between decrease of the hump fat and reduced fat content in milk (figure 33).

The fat concentration was high at the beginning of lactation when the fat in hump was also at his maximum. The hump fat decreased along the lactation due to destocking and when the peak of lactation occurs the fat concentration is at minimum level in milk. The reverse appears at the end of lactation, when fat milk concentration increased and hump fat was stored. As reported [130] in cows the milk-fat is chemically similar to adipose tissue because milk-fat production is heavily dependent on the mobilisation of body fat. So, the hump fat directly has impact to milk fat.

The fat content of milk of camel OO was between 6.8 g and 28.9 g when hump weight was in this camel 5316g and 7617 g (figure 33).

The camels 52 and 69 were in intermediate group: when the fat content of milk of camel 69 ranged between 4.5 g and 19.5 g, the hump weight was between 9 and 15 kg (figure 32).

The high fat content was in milk of camel 62. Hump weight of this camel ranged between 13500 g and 19820gr.

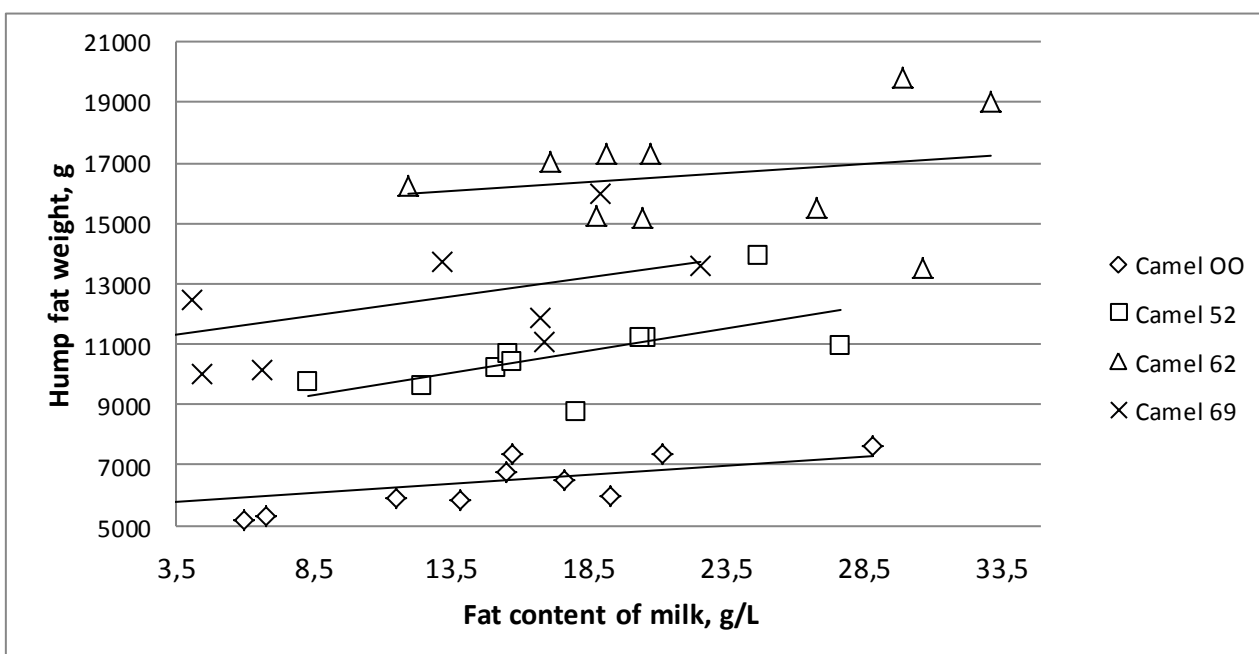


Figure 33-Relationship between the fat content of milk and the weight of the hump

The calculation of ratio between milk fat and hump weight can be used for interpreting the distribution of PCBs between tissues.

3.2 Metabolism of PCBs and DDT (E)

The metabolism of POPs includes the intake, the transport in biological fluid in blood and lymph, their storage in adipose tissue and the excretion through feces, urine and milk. In the frame of our experiment, only concentration in blood, storage in hump fat and excretion in milk has been assessed.

Due to the high individual variability, the results are given for each camel. For a better understanding, the results were expressed according to the 3 main periods of the experiment: (1) the mean of values during the two months of contamination (contamination period), (2) the mean of values during the first 2 months of decontamination, and (3), the mean values during the last two months of decontamination.

However, the kinetic will be presented by taking in account the mean of the 4 camels and the sum of PCBs in one hand and of DDT/DDE in another hand. To interpret the time variability, a polynomial model of order 5 has been retained to interpret the results properly regarding the concentrations and quantities of PCBs and DDT in the different matrix (serum, fat, milk).

The results will be expressed by the mean of four camels within three periods: period 1 – contamination period; period 2 – first two month of decontamination period with fat mobilization; period -3 – second two months of decontamination period with fat storage. The statistical differences between the 3 periods were assessed by variance analysis (ANOVA) using XLstat software (Addinsoft ©). Only the difference between periods was tested.

3.2.1. Assessment of blood transportation of PCBs and DDT in blood serum

Successively, the results will include the measured concentrations of POPs (PCB and DDT) and the estimation of the total quantity in the serum. In order to simplify the presentation of the results, the figures will express only the variation between periods of the sum of PCB congeners and of DDT+DDE.

3.2.1.1. The concentration of PCBs in blood serum

The concentration of PCBs congeners in blank blood sample (background level) was very low (mean 5.9 ng/L) testifying of a low natural contamination of the animals. The concentration in blood serum of experimental camels varied mainly for the light PCBs (28 and 52) and mainly for elder camels 62 and 69. In contamination period the concentration of PCBs ranged between 494 ng/L (PCB 28) and 1.2 ng/L (PCB 52). On average, the PCB values were higher in the second period but due to the low statistic power (only 4 animals with high between-camel variability), the difference was not significant (figure 34). However, there were different behaviors according to congener. For example, in the first two months of decontamination period the concentrations increased highly for PCB 28 (972 ng/L) then after for PCB 52 (398.8 ng/L) especially in elder camels 62 and 69. This light PCBs markedly increased for camels OO (186 ng/L) and 52 (517.7 ng/L). The concentration for other PCBs increased not significantly (70 ng/L and less) relatively to contamination period).

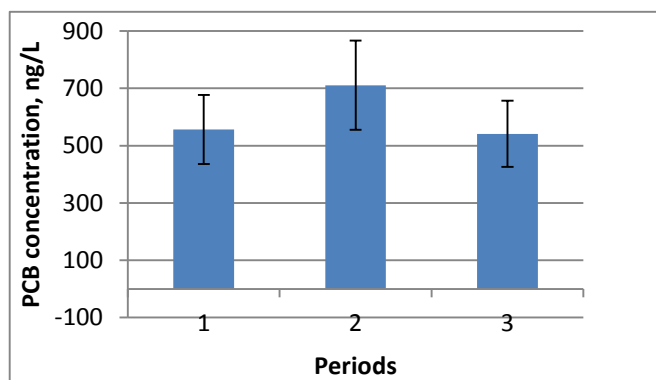


Figure 34-Mean concentration of PCBs and SEM in serum during the 3 periods of experimentation (1: contamination; 2: first 2-month decontamination; 3: last 2-month contamination)

At the end of decontamination period, again the concentration of light PCBs 28 and 52 were higher than other heavier PCBs. The concentrations of PCB 28 and 52 were higher in serum blood of camel 62 (PCB 28 - 782 ng/L, PCB 52 – 311.4ng/L), than in contamination and first two months of decontamination periods. And the data for camel 69 was the opposite of a camel 62: the concentration of PCB 28 (342 ng/L) and 52 (131 ng/L) decrease in contamination and at the end of decontamination periods.

For other PCBs 101, 118, 138, 153 and 180, the concentrations were lower than 50 ng/L for all camels. During all experimental time (contamination, first two months of decontamination and end of decontamination periods) the concentration ratio between PCBs was generally similar.

3.2.1.2 The concentration of DDT/E in blood serum

In contamination period the concentrations of DDE and DDT were below 90 ng/L (figure 37).

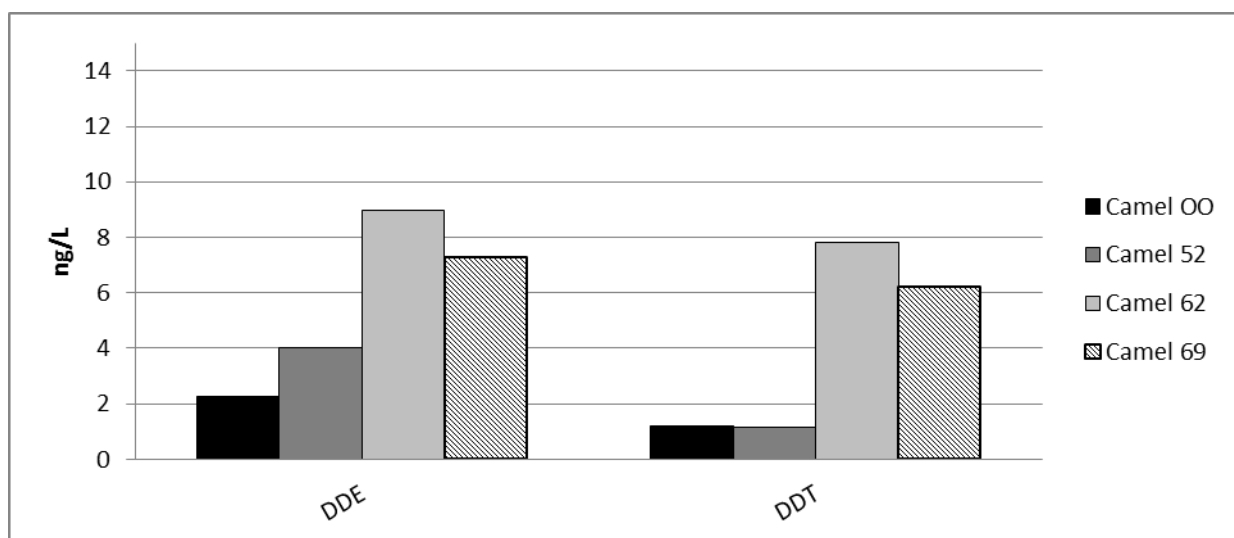


Figure 37-The concentrations of DDE and DDT in serum of blood in the contamination periods

The slightly high concentrations were for DDE in camel 62 – 9 ng/L and camel 69 - 7.3 ng/L. These figures were close to the concentrations of DDT in these camels: 62 – 7.8 ng/L and 6.2 ng/L (figure 38). In camel OO (1.2 ng/L) and 52 (1.2 ng/L) the concentrations of DDT were the same. DDE concentrations in the camel 52 (4 ng/L) was slightly higher than in camel OO (2.2 ng/L)(figure 38).

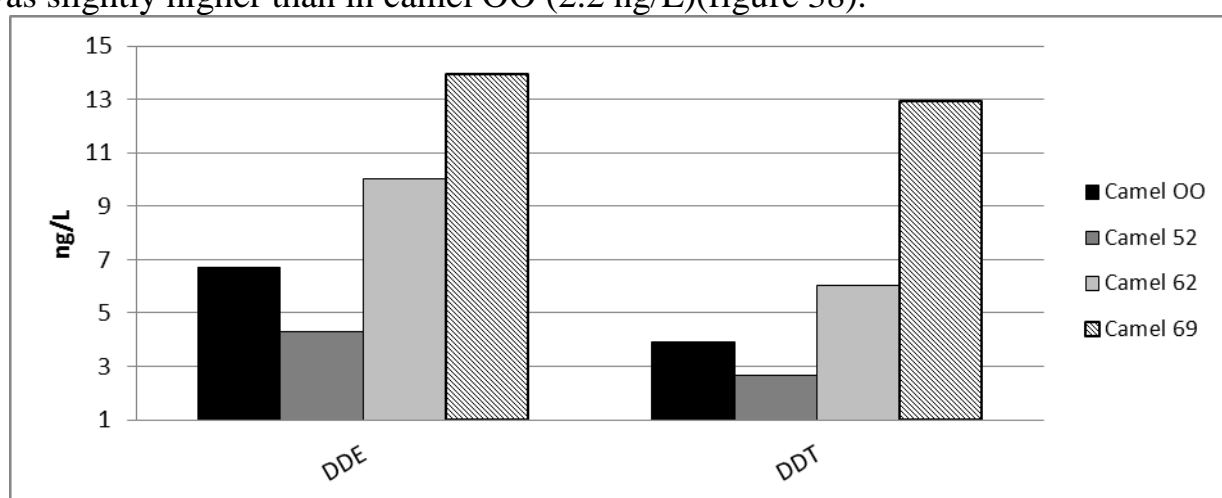


Figure 38-The DDE and DDT concentrations in serum of blood in the first two months of decontamination

In the first two months of decontamination period DDT and DDE concentrations increased (figure 49). The high concentration was observed in Camel 69 (DDE – 13.9 ng/L and DDT – 12.9 ng/L). The concentration of DDT in the other three camels were between 6 ng/L (camel 62) and 2.6 ng/L (camel 52). The concentration of DDE ranged between 10 ng/L (camel 62) and 4.3 ng/L (camel 52).

At the end of decontamination period the concentrations of DDE and DDT decreased except camel 62, which showed values of 22.4 ng/L for DDE and 11.8 ng/L for DDT (figure 39).

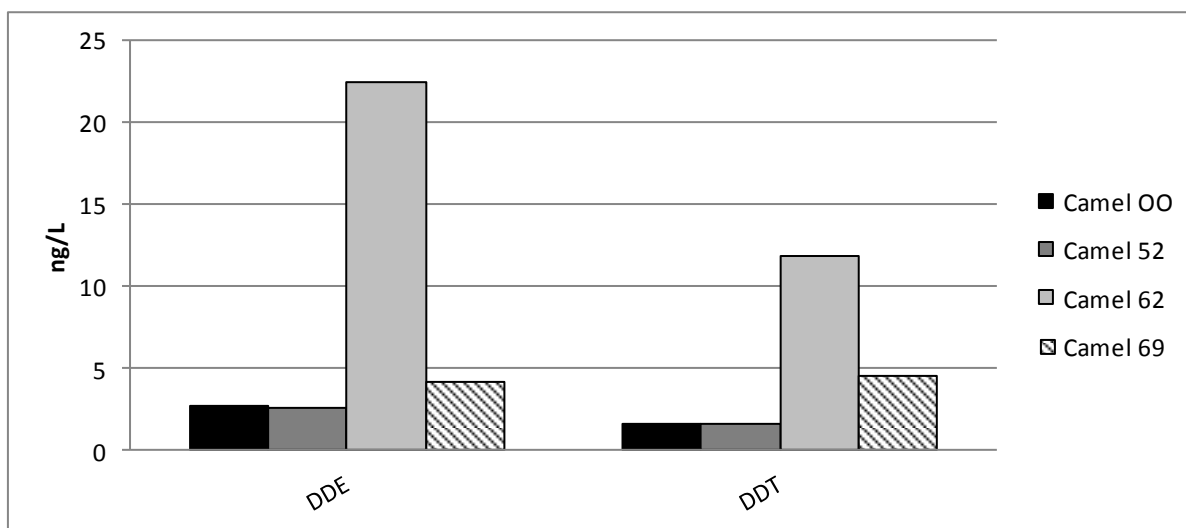


Figure 39 - The concentration of DDE and DDT in serum of blood at the end of decontamination period.

In camel 69 at the end of the trial, the concentrations of DDE (4.2 ng/L) and DDT (4.5 ng/L) were similar (figure 39). In camel OO and 52 the concentrations were below 2,5 ng/L.

3.2.1.3 The quantity of PCBs in serum of blood

The quantities of excreted PCBs in contamination period in serum of blood were high for light PCBs 28 and 52. It can be linked with more transfer ability of light PCBs to blood serum. The other PCBs (101, 118, 153 and 180) were in similar quantity (ranged between 0.24 and 0.02 ng) (figure 40).

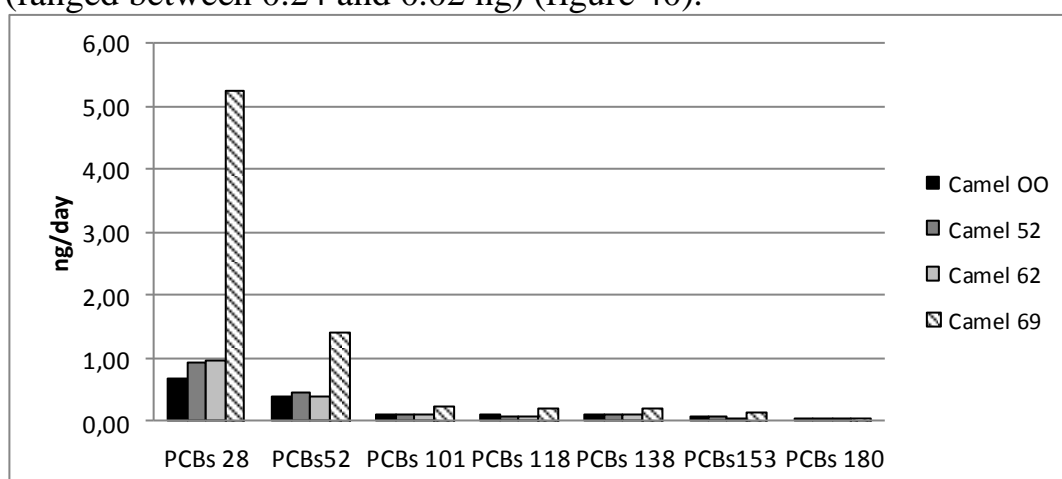


Figure 40-The amount of PCBs excreted by milk in contamination period
The very low amount was for PCBs 180 for all camels. This heavy PCBs could have low ability of transfer to blood serum.

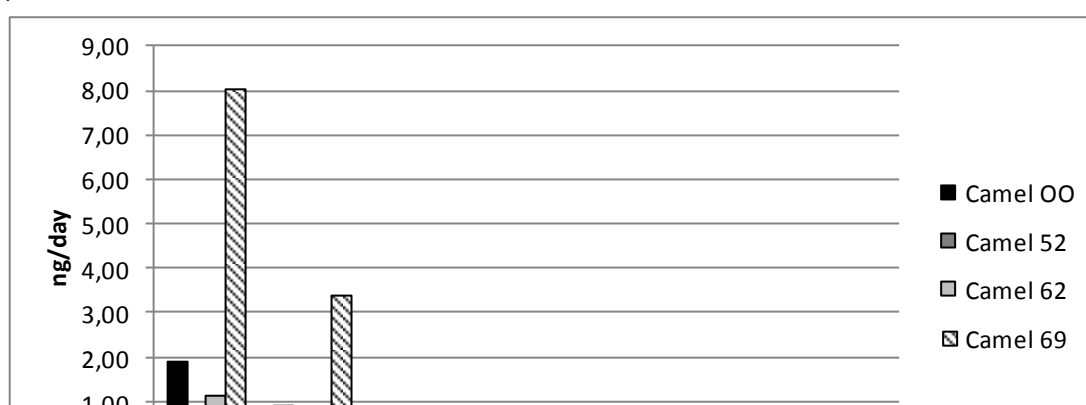


Figure 41- The amount of PCBs in first two months of decontamination period

As in contamination period, the amount of light PCBs was higher than other congeners. The huge amount of PCBs was excreted by camel 69 (8 ng per day PCB 28 and 1.89 ng per day PCB 52). The camels OO and 62 showed more excretion of light PCBs than in contamination period. The lower amount was for PCB 180 for all four camels (figure 41).

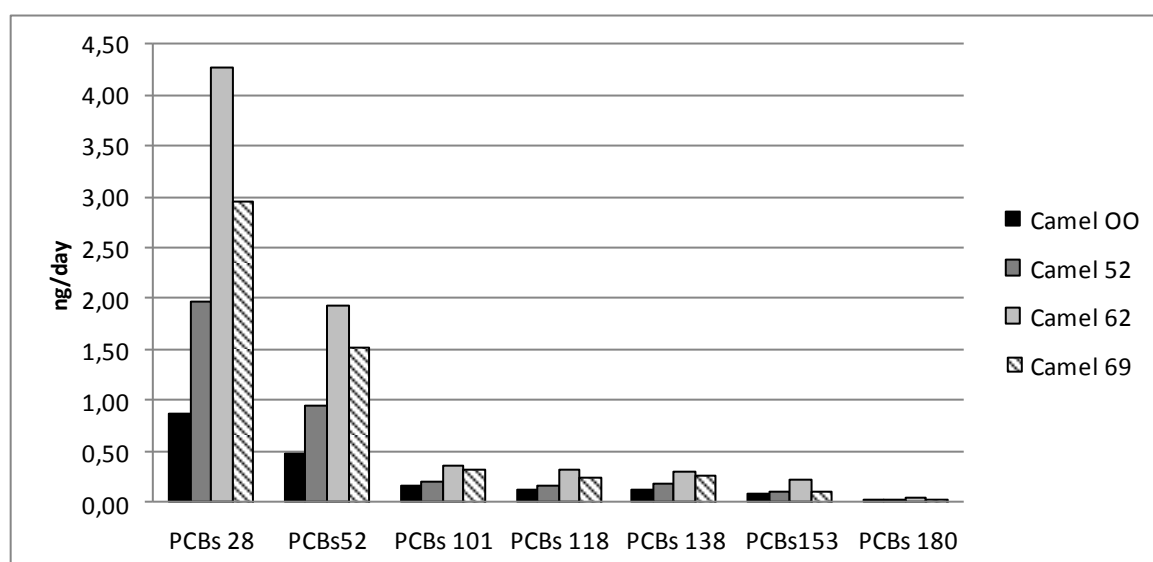


Figure 42-The amount of PCBs in serum of blood at the end of decontamination period

The excreted amount of PCBs, especially PCB 28 and 52 remained high up to end of trial for camels 62 and 69 (figure 42).

For other camels OO and 52 the excreted amount of light PCBs increased again for PCBs 28 and 52 at the end of the trial. It can be linked with increasing of body weight of all camels.

3.2.1.4 The quantity of DDT/E in serum of blood

The quantities of DDE ranged between 0.03 ng per day (camel OO) and 0.07 ng per day (camel 69) and DDT were from 0.2 ng per day (camel OO) and 0.5 ng per day (camel OO) (figure 66).

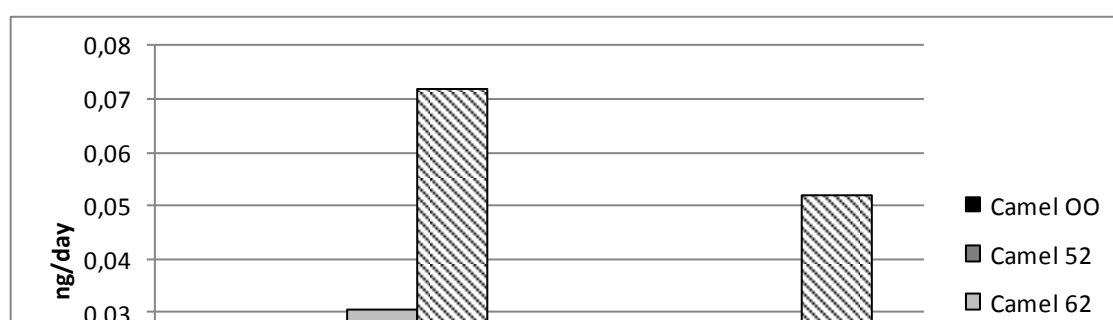


Figure 43- The quantity of DDE and DDT in serum of blood in contamination period

In contamination period the quantity of DDE was slightly higher for all camels than in DDT (figure 66). The quantities of DDE and DDT were quite similar for camels OO, 52 and 62. Camel 69 had shown 3 – 4 times more quantity in blood serum (figure 43).

In the first two months of decontamination period the quantities of DDT were similar to the contamination period except camel 69 (0.12 ng/day), which had higher quantity of DDT in blood serum (figure 44). Camels OO (0.04 ng/d), 52 (0.01 ng/d) and 62 (0.02 ng/day) had shown under 0.05 ng per day.

The quantities of DDE in camel 69 increased up to 0.23 ng per day. For camel OO the quantity was 0.07 ng per day. Other two camels 52 and 62 had shown similar quantity around 0.03 ng per day (figure 44).

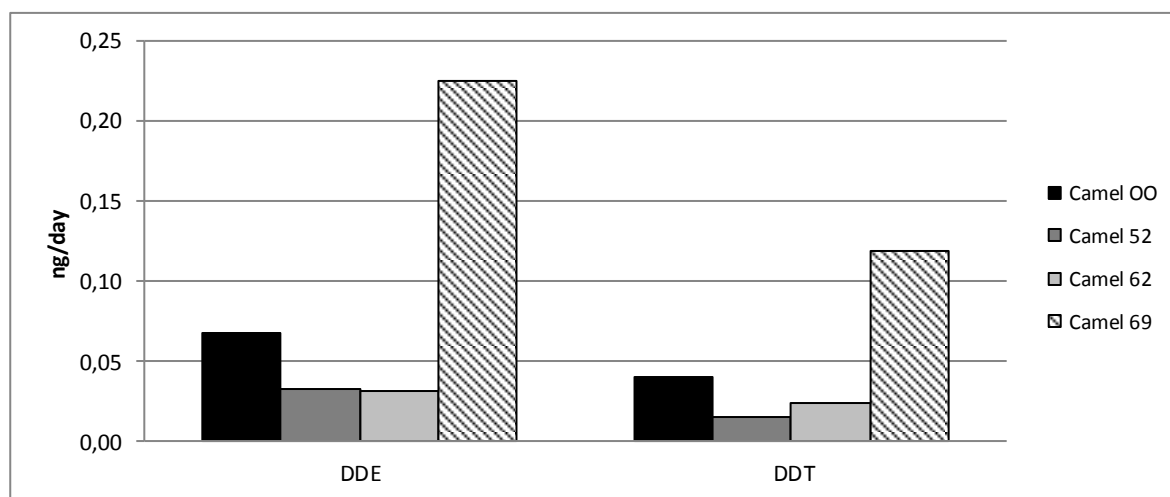


Figure 44- The quantities of DDT and DDE in first two months of decontamination period

At the end of decontamination period, the amount of DDE (0.10 ng/day) and DDT (0.07 ng/day) were higher in camel 62 than other experimental 3 camels (figure 45)

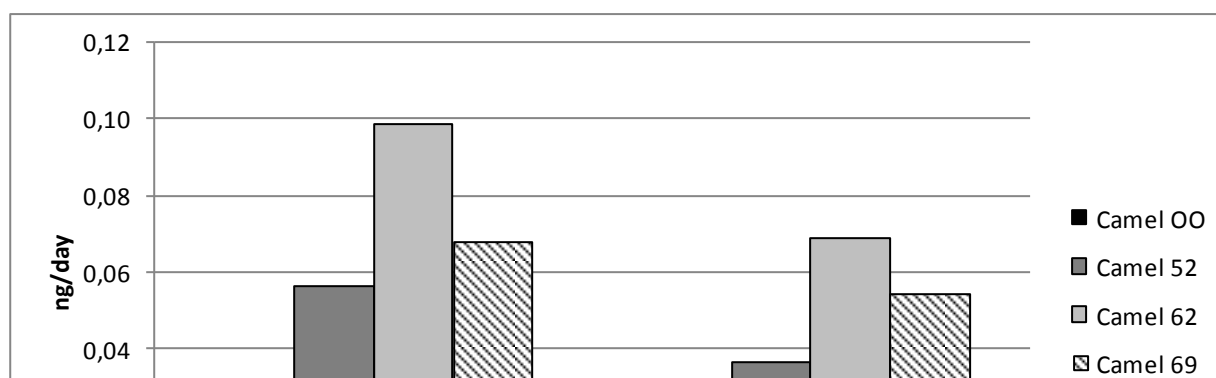


Figure 45 - The quantity of DDE and DDT in serum of blood at the end of decontamination period

The low amount of DDT and DDE were observed in camel 00 (0.03 and 0.02 ng/day). Slightly high amount of DDE and DDT were reported in camel 52 (0.06 and .0.04 ng/day). The DDE and DDT amounts in camel 69 at the end of experiment were similar to the contamination period, what ranged for DDT 0.05 ng/day and for DDE 0.07 ng/day. The total amount of DDE and DDT was very low in comparison to hump fat and milk.

3.2.1.5 Global kinetic of the serum concentrations and quantities

The kinetic was similar for PCBs and DDT concentrations with a market increase at the first two months of decontamination, then a decrease up to a similar level to the initial values (figures 46 and 47).

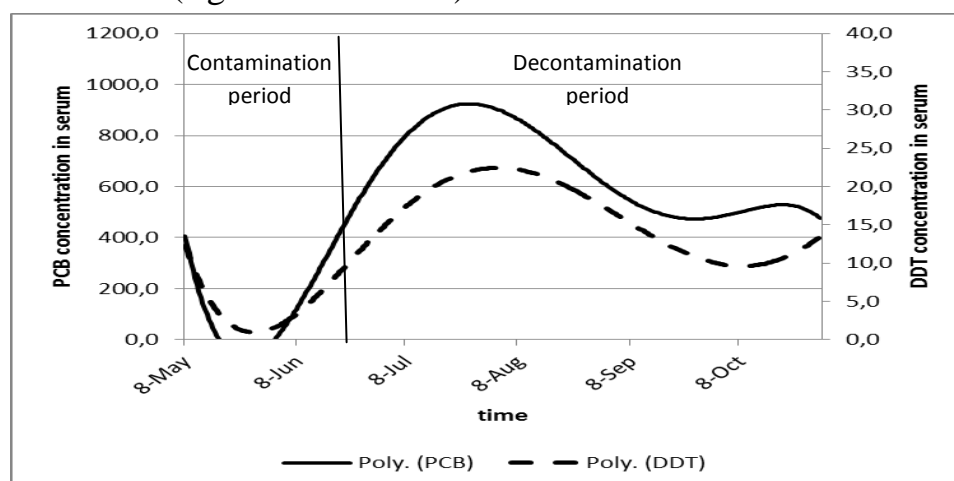


Figure 46 - Kinetic of PCBs and DDT concentrations in camel serum all along

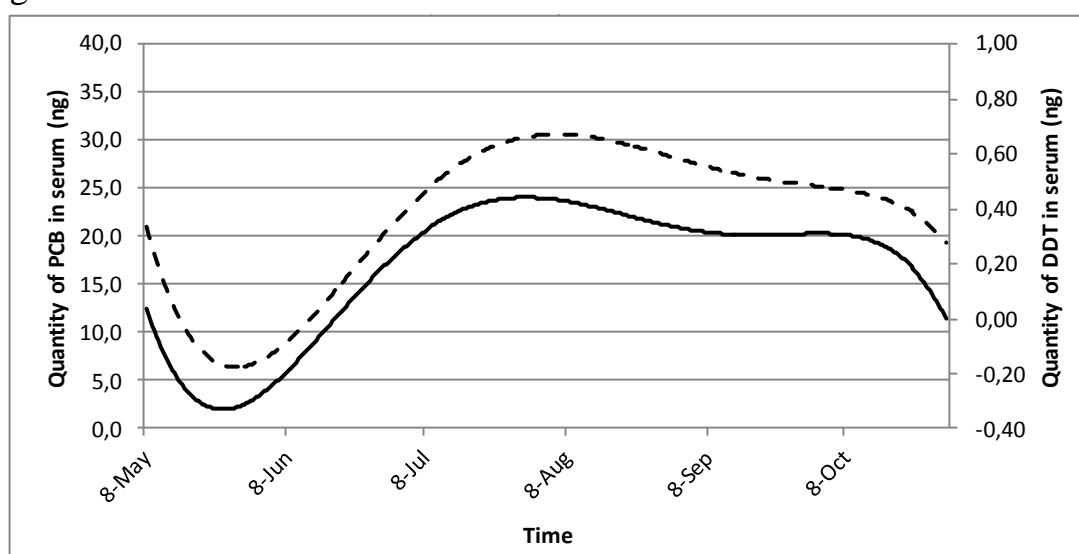


Figure 47 - Kinetic of PCBS and DDT quantity in camel serum all along the experiment

3.2.2 Assessment of PCBs and DDT storage in hump fat

3.2.2.1 The concentration of PCBs in hump tissue

According to the concentration of PCBs in blank fat sample, the contamination due to the environment led to a concentration of 79.2 pg/g for PCB 28 and 41.2 pg/g of fat tissue PCB 52. For other PCBs congeners the concentrations in background level were less than 13 pg/g fat tissues.

In contamination period, the PCBs concentrations ranged from 1456 pg/g to 20 pg/g of fat tissue. And generally, the high concentration corresponded to PCBs 118 and mainly for camel OO.

The light PCB 28 was higher in camel OO (645.6 pg/g) than in camels 62 and 69 (around 380 pg/g). Comparatively, the camel 52 showed minimal concentration for all PCBs in hump tissue.

The low concentration corresponded for heaviest one - PCB 180 for all camels (figure 48).

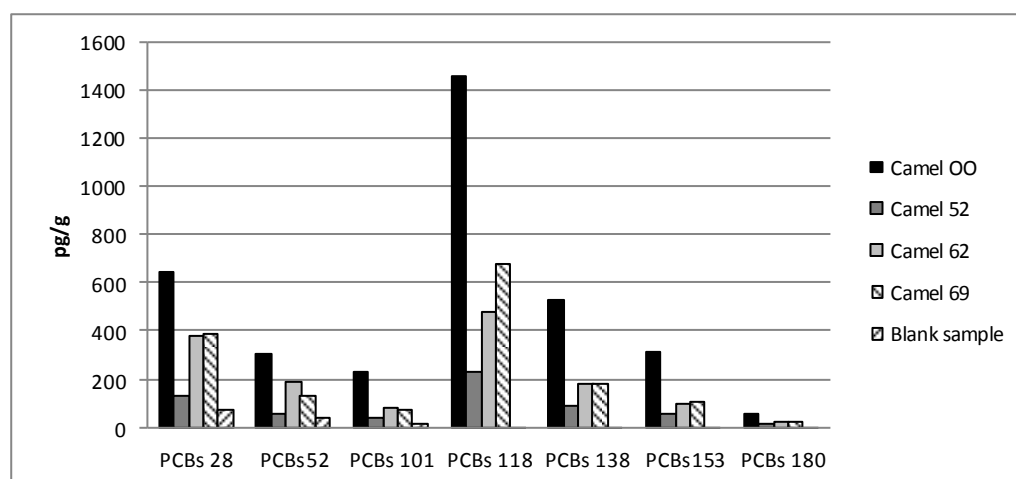


Figure 48 -The concentration of PCBs in hump tissue in contamination period

The concentration of PCBs not really changed in the first months of decontamination period, then in contamination period (figure 49). The changes in concentration ranged from 1178 pg/g (camel OO) to 13 pg/g (camel 69). As well as in contamination period the high concentration was for camel OO (1174 pg/g fat tissue PCB 118). Comparatively to contamination period, at the first decontamination time the concentration of PCBs in hump tissue of camel 62 showed 522 pg/g fat tissue of PCB 118, and for other PCB congeners 300 pg/g (PCB 28) and less

concentration. For other two camels variation of all PCBs were similar. The minimal concentration was for PCB 180 for all camels.

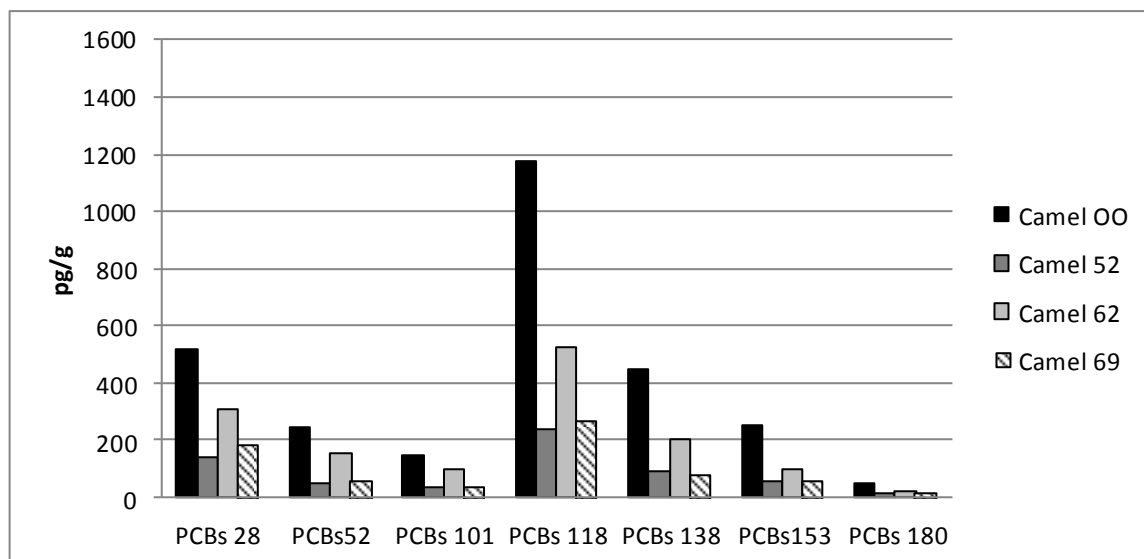


Figure 49-The concentration of PCBs in hump tissue in first two months of decontamination period

At the end of decontamination period the concentration of PCBs did not changed significantly. The most contaminated hump tissue was in camel OO for all PCBs congeners, particularly for PCB 118.

High concentrations of all PCBs were in hump tissue of camel OO, which is associated with the lowest weight of the hump (mean humps weight 6,525 kg) (figure 50).

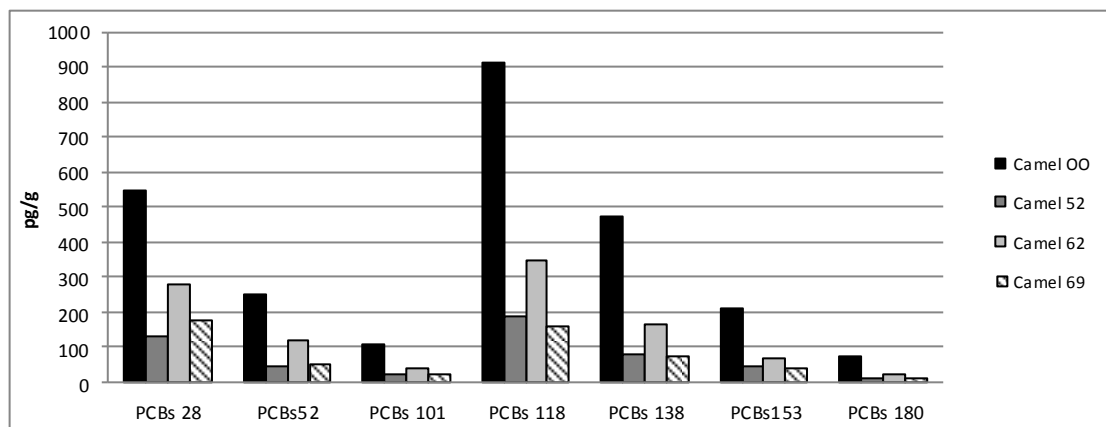


Figure 50- The concentration of PCBs in hump tissue at the end of decontamination period

3.2.2.2 The concentration of DDT/E in hump tissue

The concentrations of DDT and DDE in hump tissue were higher than in milk and serum of blood, which ranged for DDT from 18.4 pg/g to 8.4 pg/g of fat tissue, for DDE between 19.6 and 5.9 pg/g pf fat tissue (figure 51).

DDE was higher in camel OO (19.6 pg/g) than in other three camels, which showed values below 7.5pg/g of fat tissue. DDT was higher in camel 62 (18.4 pg/g)

then in camel 69 (13.4 pg/g). In camels OO and 52, there were 8.8 and 8.2 pg/g of fat tissue (figure 51).

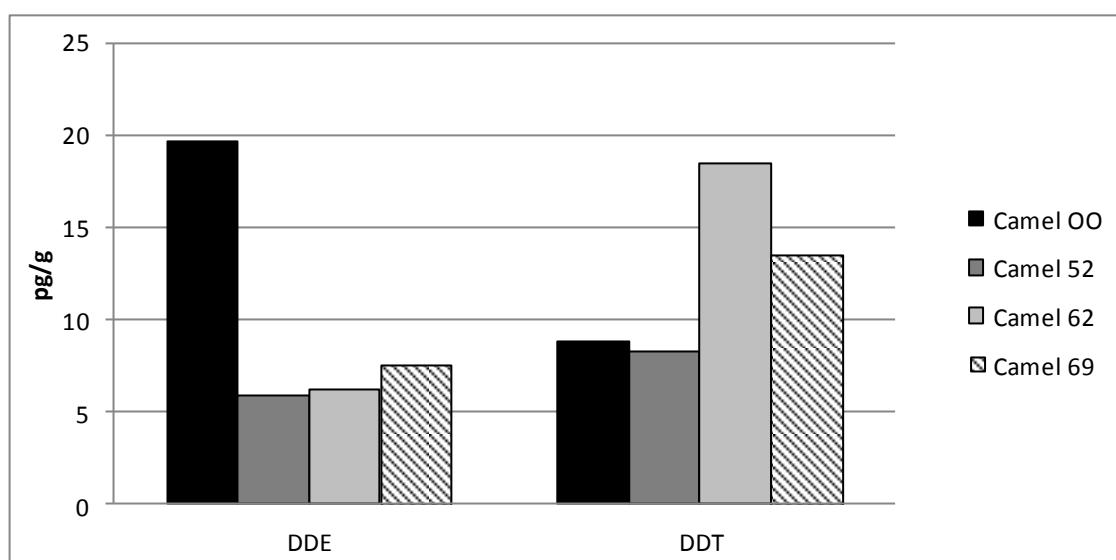


Figure 51-The concentrations of DDT and DDE in hump in concentration period

In comparison with first two months of decontamination period the concentration of DDE and DDT slightly decreased, except camel 62 for DDT (figure 52). The camel 69 had showed more lower concentration in DDT and DDE than other camels.

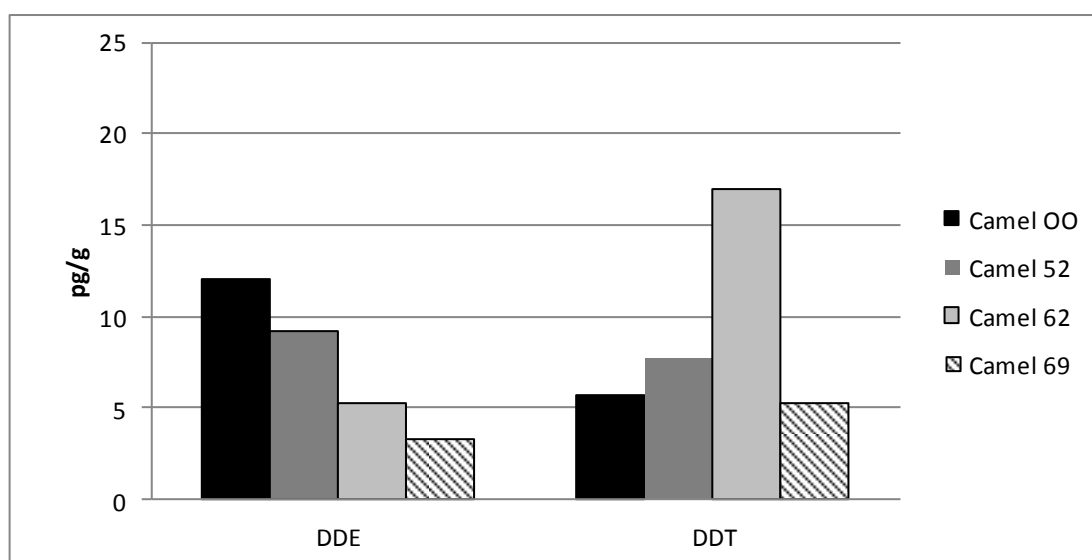


Figure 52-The concentration of DDT and DDE in hump fat tissue in the first two months of decontamination period

At the end of the trial, the concentration was almost unchanged in comparison with the first of decontamination period. The concentration of DDT was higher for camel 62 (18.5 pg/g of fat tissue) (figure 53).

For DDE, concentrations ranged between 12.1 pg/g of fat tissue (camel OO) and 2 pg /g (camel 69) of fat tissue (figure 18). For both pollutants the camel 69 showed low concentration (DDE 2.0 pg/g and DDT 3.5 pg/g).

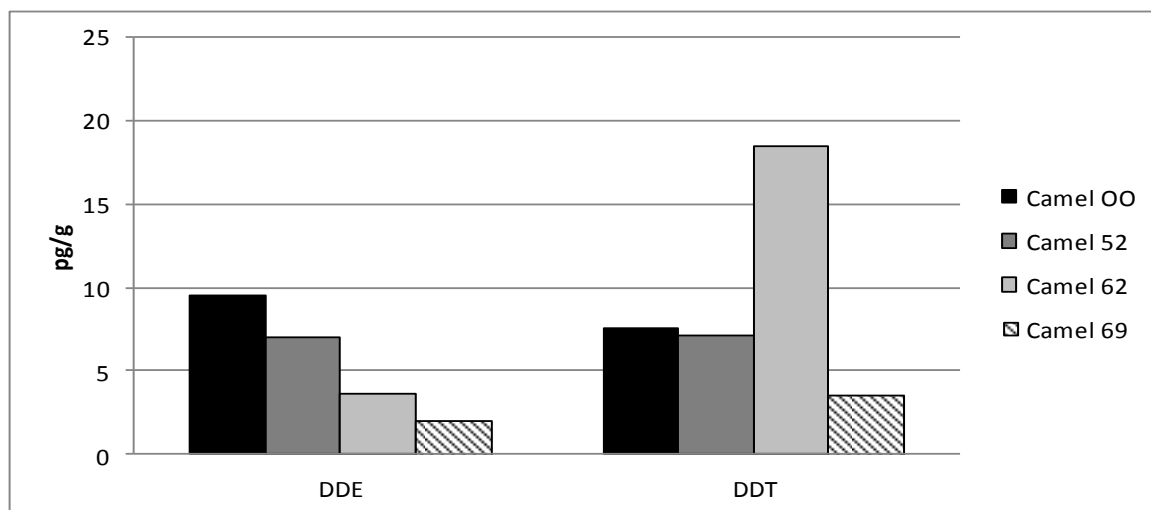


Figure 53-The concentrations of DDT and DDE in hump fat tissue at the end of decontamination period

3.2.2.3 The quantity of PCBs in hump tissue

As expected the amount of PCBs was higher in hump than in blood because contrary to blood which are flow where the pollutants are in transit, the hump is the main storage organ. The amount in hump ranged between 7524 ng/d (PCB 118) and 217 ng/day (PCB 180). In contamination period a high quantity of PCB 118 for camels OO (6820 ng/day) and camel 69(7524 ng/day) was observed. In camel 69,high value PCB 28(6495 ng/day) was also revealed. For other PCBs like PCB 52 and 138 the amounts were between 2000 – 3000 ng/day, except camel 52 and camel 62 for PCB138. For PCBs 101 and 153 amounts of stored PCBs were around 1000 ng/day.

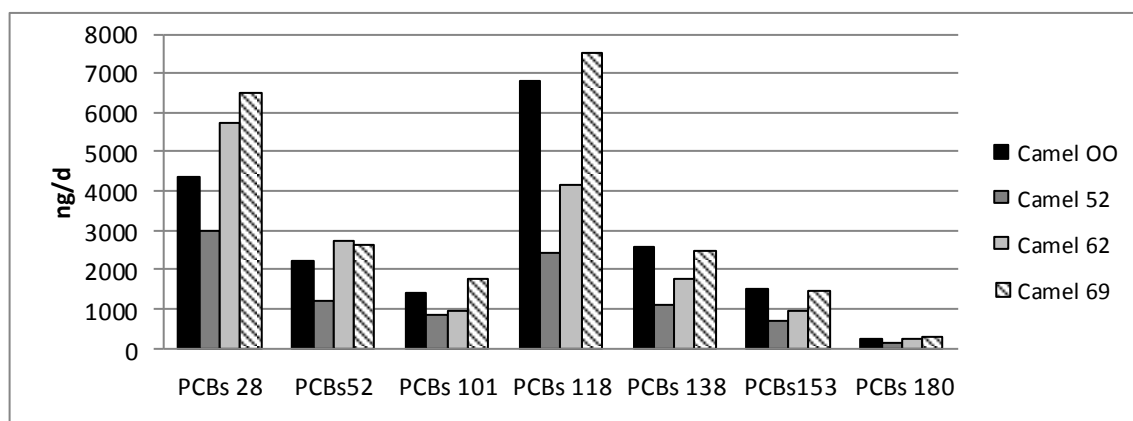


Figure 54-The amount of PCBs in hump fat tissue in the first two months of decontamination period

And very few amounts in comparison with other PCBs was PCB 180 (mean 250 ng/day) (figure 54).

In the first two months of decontamination periods, for all PCBs except PCB 118, the mean amount were less than 3000 ng/day for all camels (figure 55).

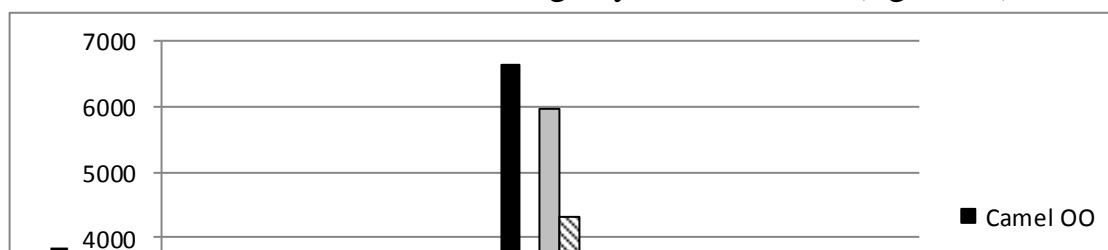


Figure 55 - The mean concentration of PCBs in hump of Camels

These decreases of pollutants can be linked to the decrease of hump weight in the middle of the trial, corresponding to the hot season. The PCB 118 was high for camel OO (6628 ng per day), camel 62 (5955 ng per day) and 69 (4307 ng per day).

At the end of decontamination period the amounts in hump fat slightly increased again, corresponding with the fat storage in hump close to winter season (figure 56).

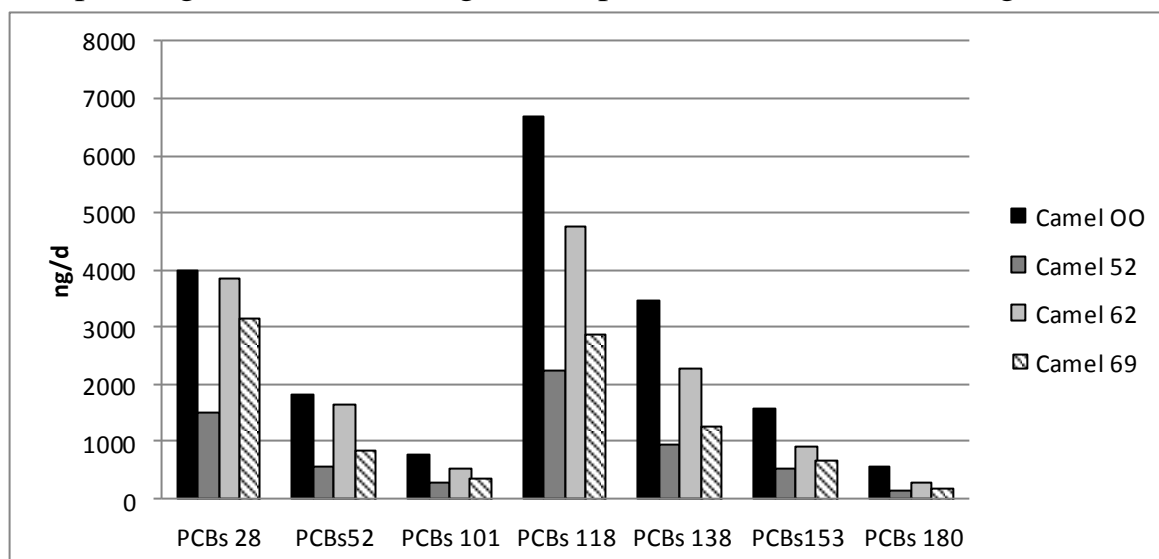


Figure 56 - The amount of PCB in hump at the end of decontamination period

3.2.2.4 The quantity of DDT/E in hump tissue

In contamination period the quantities of DDE (394 ng/day) and DDT (177 ng/d) was higher in camel 69 than other camels, except the concentration of DDT in camel 62 (180 ng/d) (figure 69). The concentrations of DDT were similar for camels OO (67.9 ng/d) and 52 (79.2 ng/d). The concentrations of DDE were similar in camels OO (137 ng/d) and 52 (168 ng/d) (figure 57).

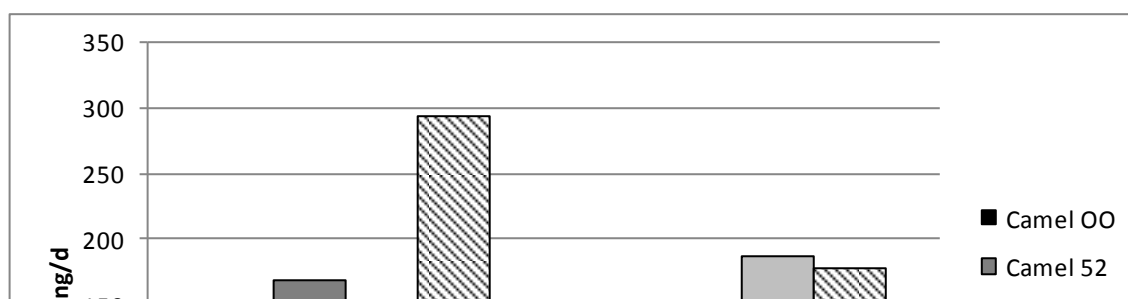


Figure 57-The quantities of DDT and DDE in hump in contamination period

In the first two months of decontamination period the quantities of DDE and DDT decreased except in camel 62 (194 ng/d). Regarding DDE, there were not high differences between the camels, which ranged from 60 to 90 ng (figure 70). For the DDT the camel OO showed the low quantity in compare to other camels (32 ng) (figure 58).

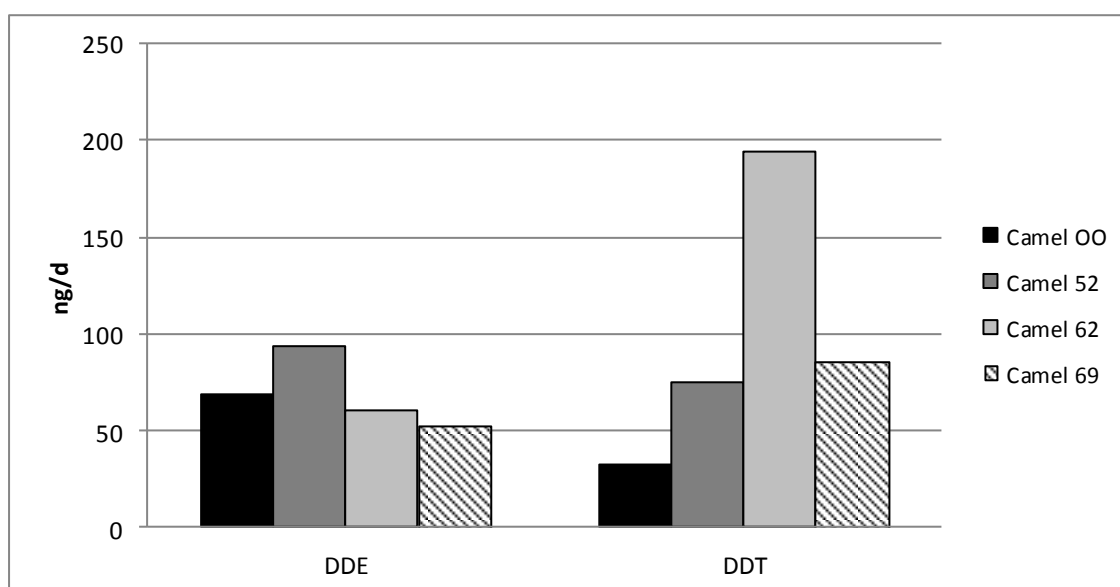


Figure 58-The quantities of DDE and DDT in the first two months of the decontamination period

At the end of the trial, the quantities of DDE and DDT were not particularly changed. Only the camel 62 slightly increased (figure 59).

All other camels showed the quantities for DDT between 82 ng per day and 55 ng per day and for DDE were between 76.6 ng per day and 35.4 ng per day.

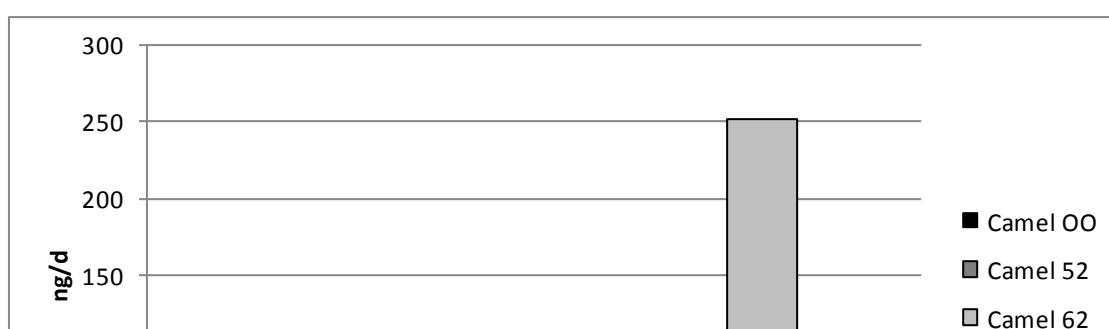


Figure 59 - The quantities of DDE and DDT at the end of decontamination periods.

3.2.2.5 Kinetic of PCBs and DDT concentrations and quantities in hump tissue

The concentrations and quantities of pollutants increased during the contamination period for both contaminants and decreased as soon as the decontamination period started (even before for DDT) and in proportion with a more important decrease for DDT than for PCB (figures 60 and 61).

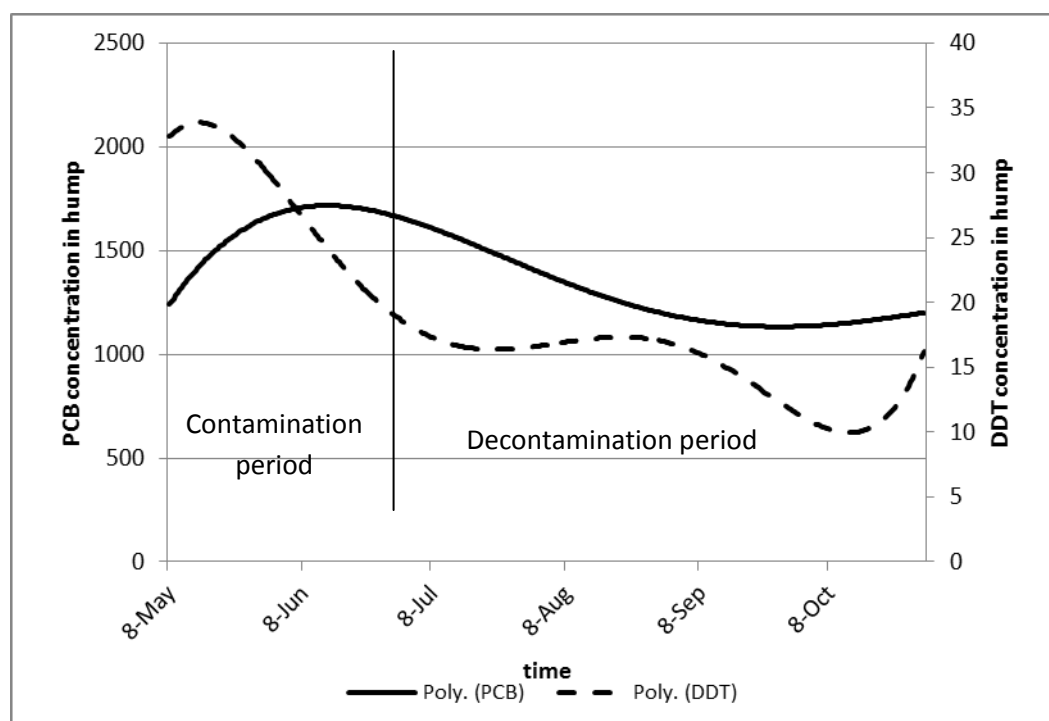


Figure 60 - Kinetic of the PCBs and DDT concentrations in the hump tissues of Bactrian camel all along the experiment

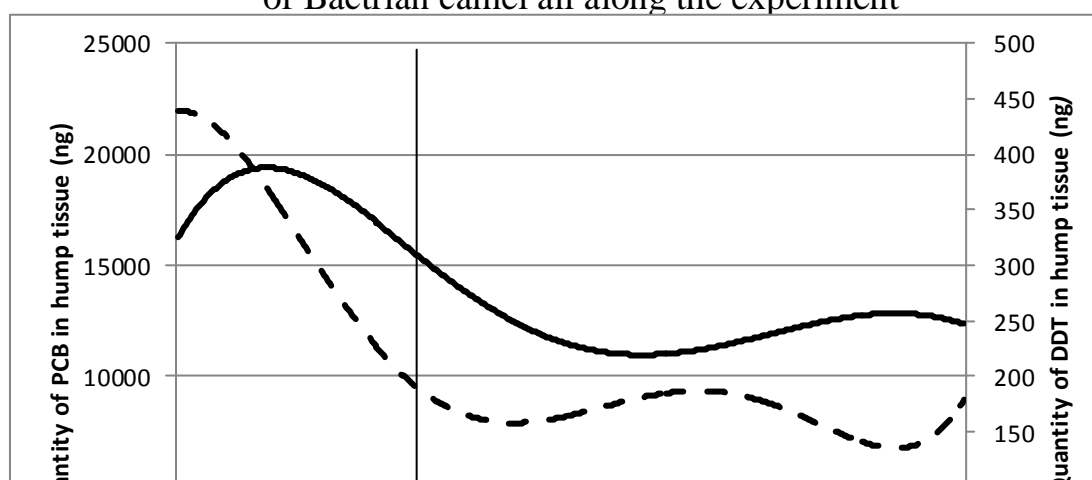


Figure 61 - Kinetic of the PCBs and DDT quantities in the hump tissues of Bactrian camel all along the experiment

3.2.3 Assessment of milk excretion of PCB and DDT

3.2.3.1 The concentration of PCBs in excreted milk

Because the milking difficulties of camel 62, his milk yield seems not reliable and has been excluded from the data analyses. Therefore, the concentrations of PCBs in milk have been described only for 3 camels (camels OO, 52, 69). The background level measured in blank milk is shown beside the measured concentrations (figure 62).

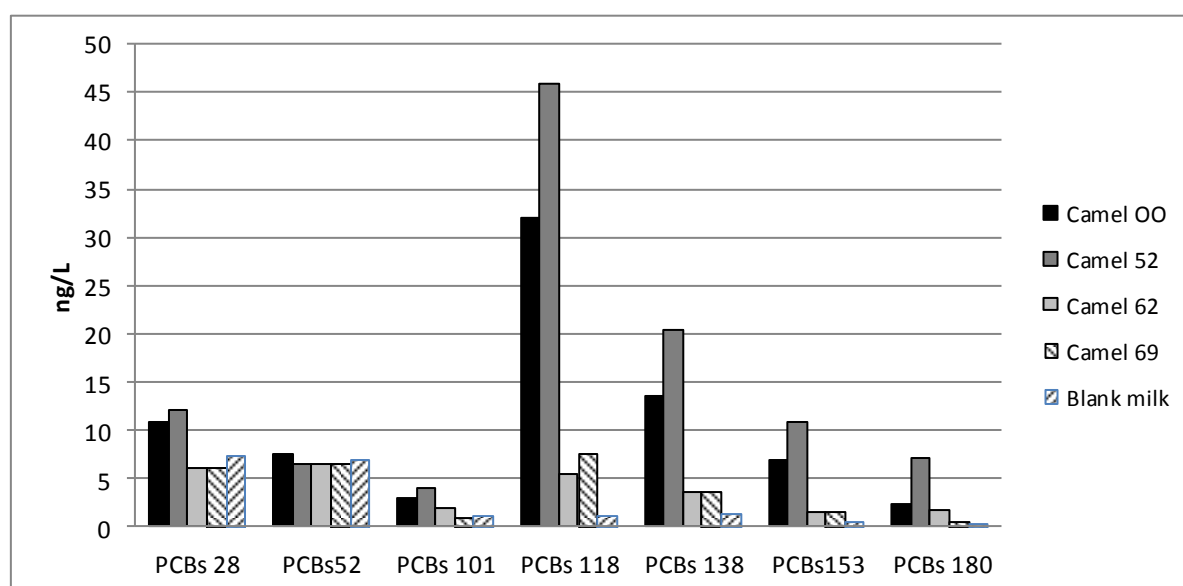


Figure 62-The concentration of PCBs in milk of contamination period

At the end of the contamination period (figure 62), the concentrations of PCB 28 and PCB 52 were quite similar in milk of camels OO and 52 in comparison to blank milk. For the other PCBs (101, 118, 138, 153 and 180) these two camels had strongly increased concentrations in milk in comparison to the background concentrations. Finally, camel 69 had also increased concentrations in comparison to the background but in a lesser extent (figure 62).

The concentrations of PCBs of the three other camels milk ranged: for light PCBs 12.03ng/L (PCB 28) and 0.96 ng/L (PCB 101); for heavy PCBs the

concentration ranged between 0.40 ng/L (PCB 180) to 45.79 ng/L (PCB 118). The concentrations of PCBs 118 and 138 were in high value for Camel 52 (more than 15 ng/L) and Camel OO (more than 10 ng/L). Other PCBs distribution on milk in contamination period appeared similar (between 10 ng/L and 0.30 ng/L) (figure 62).

There are two versions for explaining the high concentration of PCB 118 in milk of Camels OO and 52: first it can correspond to low milk yield and high fat content of the milk. Second the percentage of this PCBs in Aroclor 1254 is higher than other PCBs congeners.

In first two months of decontamination period the concentration of PCBs decreased significantly (around 6 ng/L and less) (figure 63).

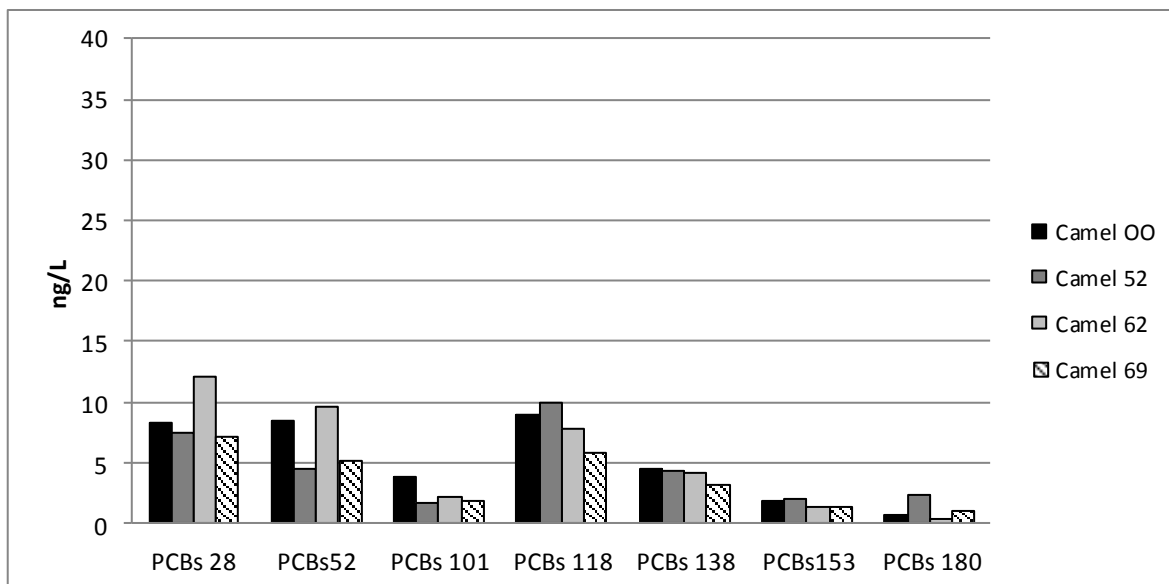


Figure 63 – The concentration of PCB in milk in first two months of decontamination period.

After stopping oral exposure, the values immediately came down for all camels, that can be linked to distribution of the pollutants in other organs.

In the next two months of decontamination period, the concentration of light PCBs (PCB 28, PCB 52) increased significantly for camels OO and 52. This concentration was approximately 3 times more for camel OO and 2 times more for camel 52 than in contamination period. At the end of decontamination period the concentration of PCBs was low in Camel 69. The younger camels OO and 52 had high concentrations.

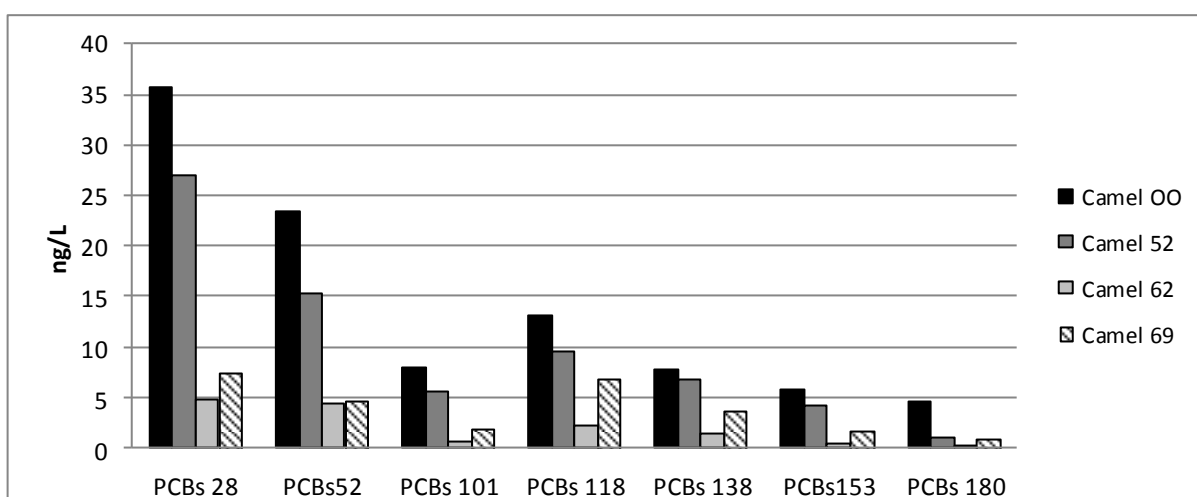


Figure 64 - The concentration of PCBs in excreted milk at the end of decontamination period

To check reliability of our analyses, the milk samples of camels 52 have been analyzed for PCBs in the set of reference laboratories of Europe “CARSO” in Lyon (France). Six iPCBs (PCBs 28, 52, 101, 138, 153, 180) and DL-PCBs (PCBs 180) were analyzed (appendix 5). The light PCBs, such 28 and 52 are very similar in the results of both laboratories. For heavy PCBs, such 101,118,138,153 and 180 the curves are the same, but there are differences in concentrations.

3.2.3.2 The concentration of DDT/E in excreted milk

The concentrations of DDT and DDE were much lower than PCB. In comparison between DDT and DDE, the concentration of DDT was slightly higher than DDE (figure 65).

The DDT concentration ranged between 0.61 ng/L (Camel OO) and 0.87ng/L (Camel 52). There was not high differences between camels for DDE: camel OO- 0.23 ng/L, camel 52 – 0.27 ng/L and camel 69 – 0.29 ng/L (figure 65). Generally, between camels there was low differences in distribution of concentration of DDT and DDE.

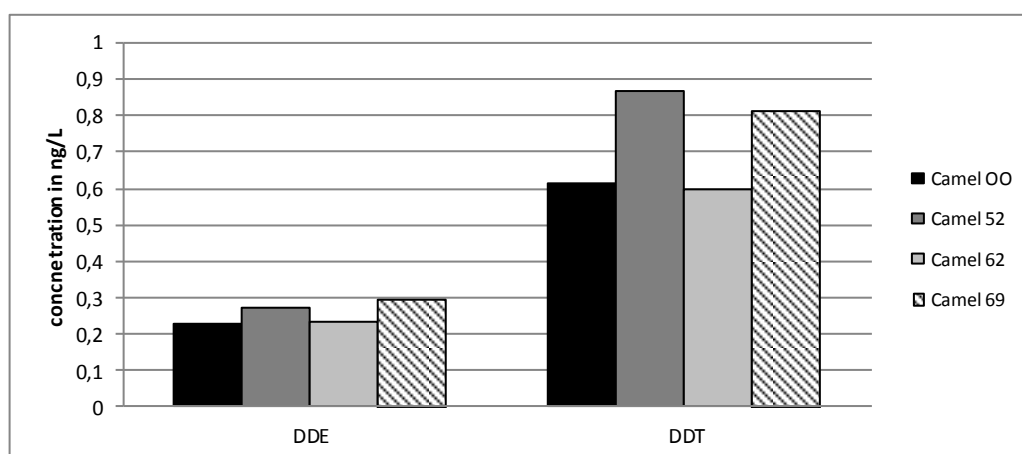


Figure 65-The concentration of DDT and DDE in milk in the contamination period

In the first two months of decontamination period the concentration of DDT and DDE slightly increased (figure 66).

In camel 52, the concentration was medium(1 ng/L). In camel 69 the concentration of DDT was around – 0.60 ng/L. The concentrations of DDE were similar for all camels (around 0.20 ng/L).

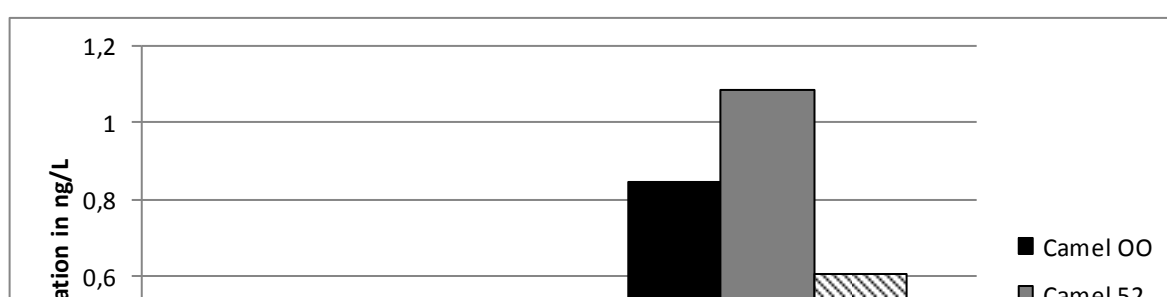


Figure 66-The concentration of DDT and DDE in milk in the first two months of decontamination period

In comparison to contamination period the concentration of DDT at the end of trial increased approximately 4 times (figure 67). The milk of camel 52 showed 4.14 ng/L, when in contamination period it was much lower (figure 67).

The concentration of DDT was 2.59 ng/L for camel OO and 1.07 ng/L for camel 69. This figure was more higher than in contamination period.

The concentrations of DDE were below 0.72 ng/L for all camels (figure 67).

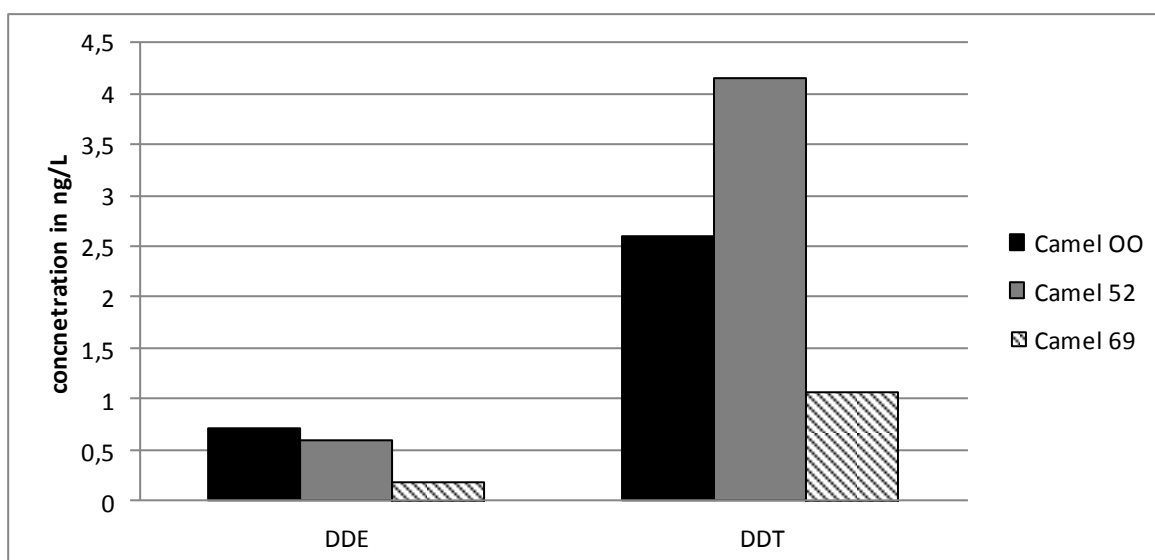


Figure 67-The concentration of DDT and DDE in milk at the end of decontamination period.

3.2.3.3 The quantity of PCBs in excreted milk

The daily excreted amounts of all PCBs congeners were above the exposure period in comparison to the previously measured background level (figure 68).

In contamination period the daily excreted PCBs amounts were high for congener 118 in camel milk OO (102 ng/d) and 52 (114 ng/d). For light PCBs the amounts were around 30-40 ng/day in all three observed camels. Comparing, excreted PCBs by camels, the younger camels OO and 52 transferred more to the milk except PCBs 28 and 52.

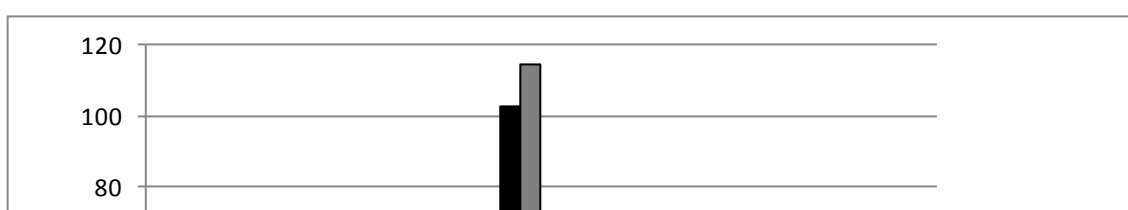


Figure 68-The amount of PCBs excreted by milk in contamination period

Nevertheless, the lower excretion in first two months of decontamination period let suppose an overestimated background level, possibly linked to environmental presence to these congeners, as described above in figure 21. The excreted amount of PCBs 28, 52 and 118 ranged between 12-27 ng per day. For other PCBs excreted amount were less than 11 ng/day. The ratio between congeners was quite similar for each camel (Figure 69).

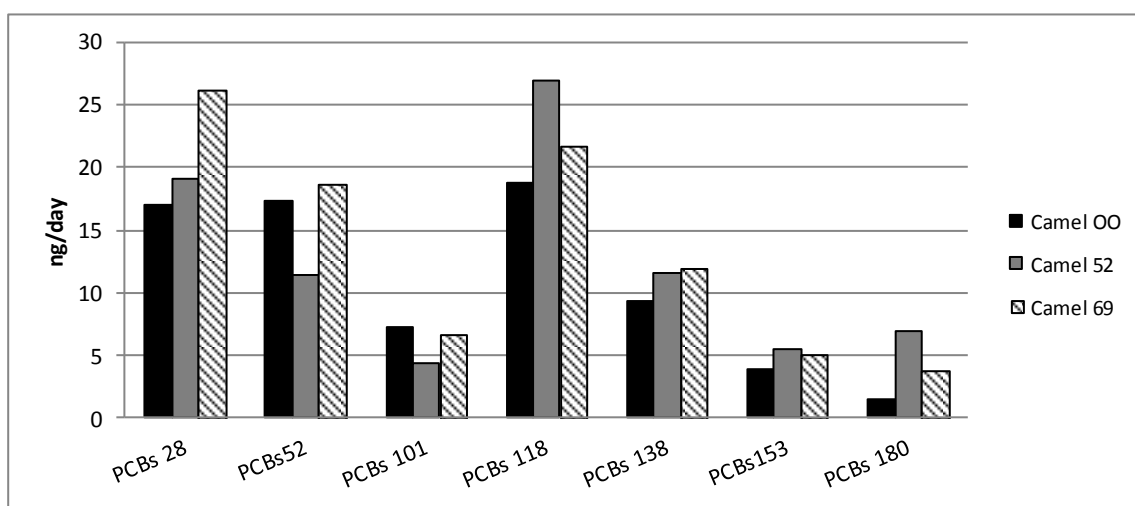


Figure 69-The amount of PCBs excreted by milk in first two months of decontamination period

At the end, of the trial the daily excreted amounts of all chlorinated congeners increased again in autumn when animals reconstructed their fat reserves in humps for winter (figure 70)

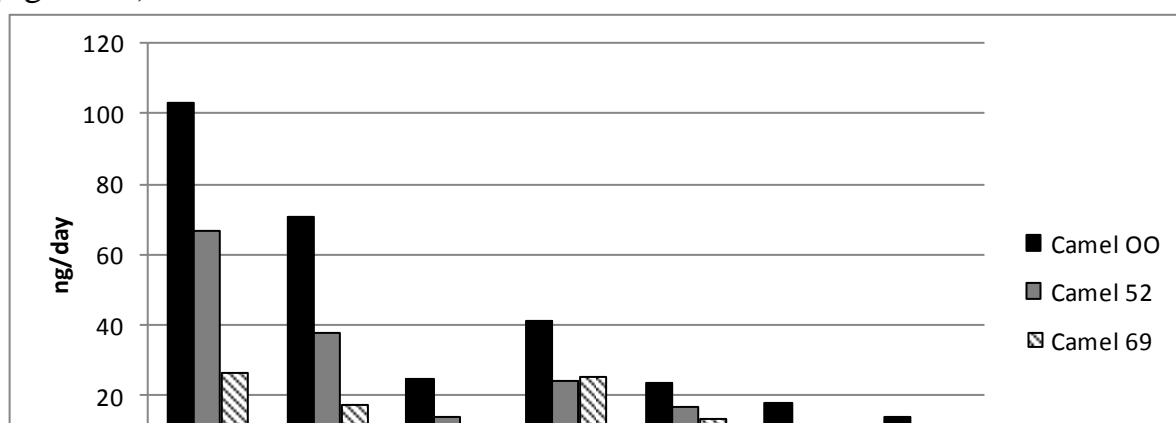


Figure 70- The amount of excreted PCBs by milk at the end of decontamination period

In last months of decontamination period the excreted amount of light PCBs were high for camel OO (PCB 28 – 103 ng/d and PCB 52 – 70 ng/d) and camel 52 (PCB 28- 64 ng/d and PCB 52 37 ng/d) (figure 70).

For PCBs 101, 118, 138 and 153 the excreted amount of these congeners was higher in camels OO and 52 than in camel 69.

3.2.3.4 The quantity of DDT/E in excreted milk

In contamination period, the quantities of DDT and DDE in milk were between 0.7 ng/d for and 2.2 ng/d and between 1.9 ng/d and 5.2 ng/d respectively figure 71).

The camel OO had lower quantities of DDT (1.9 ng/d) and DDE (0.7ng/d) than other camels. The camel 52 was in intermediate group and had the quantities of DDE at 1 ng/d and DDT 3.7 ng/d. In the camel 69 high quantity of DDE (2.2 ng/d) and DDT (5.2 ng/d) was observed compared to the other camels (figure 71).

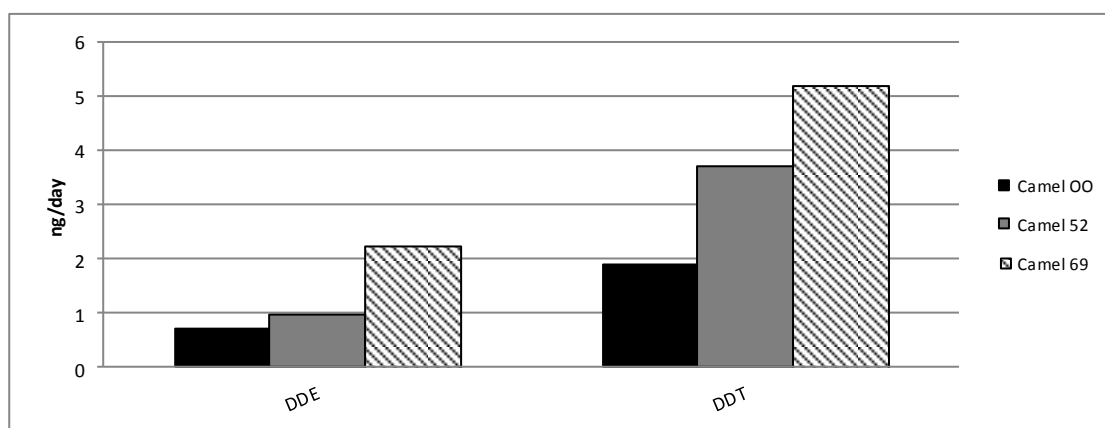


Figure 71- The quantities of DDE and DDT in milk in contamination period

In the first two months of decontamination period, the quantities of DDE came down to 0.8 ng/d and 2.9 ng/d for DDT., In the same period, a slight increase was observed with a range from 0.7 ng/d to 2.2 for DDE and from 1.9 ng/d to 5.2 ng/d for DDT. DDT showed high quantity for all observed three camels (figure 72).

Higher quantity was excreted by camel 69, with 2.2 ng per day for DDE and 5.2 ng per day for DDT.

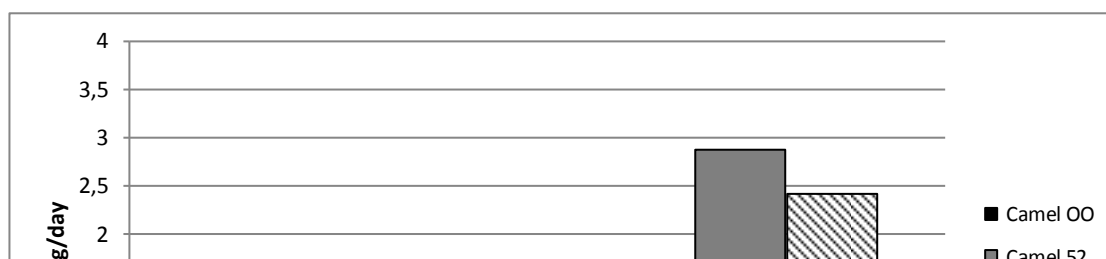


Figure 72-The quantities of DDT and DDE in milk in the first two months of decontamination period

At the end of trial, the excreted amounts of DDT were higher than in DDE.

For DDT, the quantity ranged between 3.9 ng per day and 10.1 ng per day. The amounts of DDE were between 0.6 ng per day and 2.2 ng per day (figure 73).

High amount of DDT was excreted by camel 52 (10.1 ng/d) and for DDE by camel OO (2.2 ng/d). A low quantity of DDE (0.6 ng/d) and DDT (3.9 ng/d) was reported in camel 69.

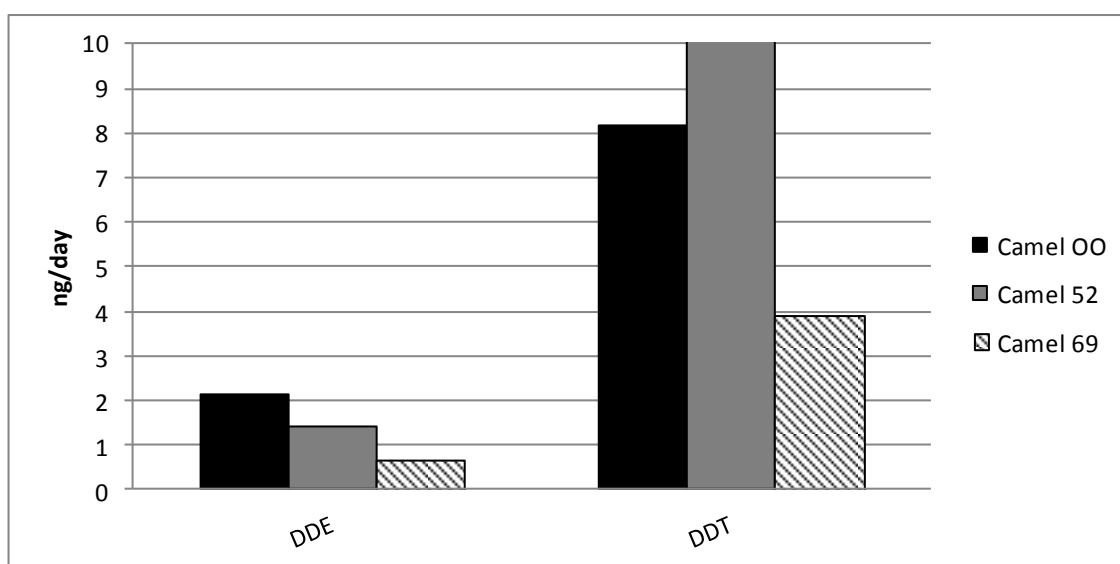


Figure 73-The quantities of DDT and DDE in milk at the end of decontamination period

3.2.3.5 Kinetic of PCBS and DDT concentrations and quantities in camel milk

The concentrations and quantities increased during contamination period, especially for PCB and increased at the end of decontamination period just before the end of the experiment (figures 74 and 75)

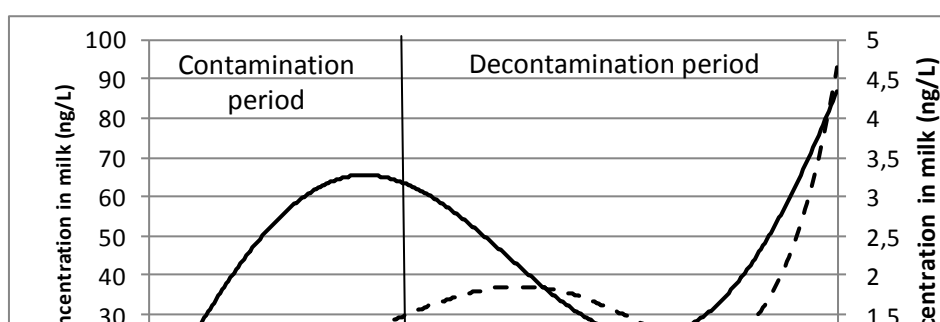


Figure 74 - Kinetic of PCBS and DDT concentrations in camel milk

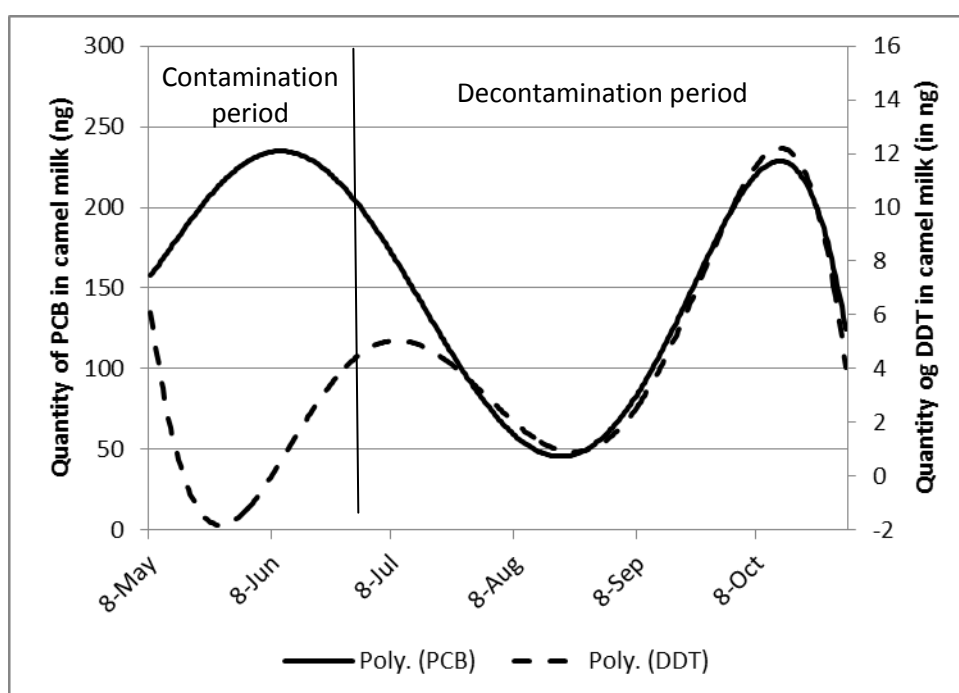


Figure 75 - Kinetic of PCBS and DDT quantities in camel milk

3.2.4 The carry over rate of pollutants in milk

The calculated carry over rates (CORs) based on plateau excretion at the end of the exposure period are shown in table 23

Table 23-Carry over rate (%) of iPCBs in camel milk in comparison to milk of other species in the literature

PCB cong.	COR %		Costera et al (2006)	Ounnas et al (2010)	Thomas et al (1999)
	CARSO	EcoBiosp	3 goats	3 goats	5 cows
PCB 28	10,4	8,9	25	nd	nd
PCB 52	0,2	0,1	10	nd	< 2
PCB101	0,4	0,02	5	nd	4

PCB 118	-	0,1	85	59	94
PCB 138	2,5	0,1	41	36	69
PCB 153	6,5	0,1	45	nd	75
PCB 180	7,7	0,7	55	nd	63

According to our results the carry over rate (COR) in camel appeared lower than for the other species.

The transfer rate of PCB 28 was 2 times less than in goats (table 23).

Non-coplanar, low chlorinated PCBs (i.e. 52 and 101) were very weakly transferred (<0.4%) into camel milk as previously reported in cows (< 2 and 4) and goats (between 5 and 10).

The mono-ortho congener (PCB 118) was transferred into camel milk to a much lesser extent (0.1%) than in goats and cows (table 10). The same tendency has been observed for hexachlorinated iPCBs: transfer rates seem clearly lower than in other ruminants and finally, the heptachlorinated PCB 180 (7.7) has been transferred at a rate at least as low as in goat – 55% and to cows 63%.

That means that low chlorinated compounds but also heptachlorinated PCB 180 have similar transfer patterns in milk from camels in comparison to other ruminants coplanar PCB 118 and hexachlorinated congeners are less transferred. This difference could be partially due to the difference in exposure dose between the studies. Indeed, we used much higher exposure doses (2.2 µg/kg BW & day) in our camels in comparison to studies on goats using only 0.03 µg/kg BW & day (Costera et al, 2006; Ounnas et al, 2010) during a similar duration of exposure (56 days for our camels in comparison to 45 to 70 days in goat studies). We cannot exclude that some transfer mechanisms, especially for highly transferred compounds, reached a saturation of absorption what would reduce mathematically the transfer rates.

3.2.5 Statistical analysis

Due to the low number of animals, the statistical analyses have to be taken in account carefully. However the global results are reported here after the description of the kinetics in the different matrix. The statistical data are summarized in table 23 giving the results of LSD test after ANOVA application.

	PCBserum	PCBfat	PCBmilk	DDTserum	DDTfat	DDTmilk
Sample effect	0.54	0,004*	0,018*	0,003*	0,075*	0,019*
Period effect	0,72	0,52	0,103	0,29	0,03*	0,108
Camel effect	0,0001**	0,0001**	0,003**	0,0001**	0,43	0,52

Table 23 - Probability level of the different factors on the variation of PCBs and DDT concentrations in serum, fat and milk of Bactrian camel

The time effect is significant on all matrix and all pollutants except for PCB in serum. However, except for DDT in fat, the period effect was not significant although some values were significantly higher by considering the pairwise LSD test (table 24). The camel effect is highly significant for PCB values contrary to DDT except in serum.

Table 24 - Probability level of the significant highest values at different sampling time for PCBs and DDT concentrations in serum, fat and milk of Bactrian camel by using the pairwise Fisher test (LSD)

Dates	PCBserum	PCBfat	PCBmilk	DDTserum	DDTfat	DDTmilk
8-May	ns	ns	ns	ns	0,005**	ns
21-Jun	ns	ns	ns	ns	ns	0,05*
26-Jun	ns	0,03*	0,023*	ns	0,03*	ns
5-Jul	ns	ns	ns	ns	ns	ns
22-Jul	ns	ns	ns	ns	ns	ns
9-Aug	ns	ns	ns	<0,0001**	ns	ns
23-Aug	ns	ns	ns	ns	ns	ns
7-Sep	ns	ns	ns	ns	ns	ns
22-Sep	ns	ns	ns	ns	ns	ns
16-Oct	ns	ns	0,018*	ns	ns	0,019*
30-Oct	ns	ns	ns	ns	ns	ns

3.2.5 Stock of pollutants in hump tissue, milk and serum of blood

The hump being the main fat storage tissue of camel organism, logically the total amount of pollutants was higher than in blood serum (flow) or milk (excretion). For example, the quantity of PCBs 52 in hump ranged between 3947 ng and 400 ng in hump (figure 76). Similar features are observed for the other congeners.

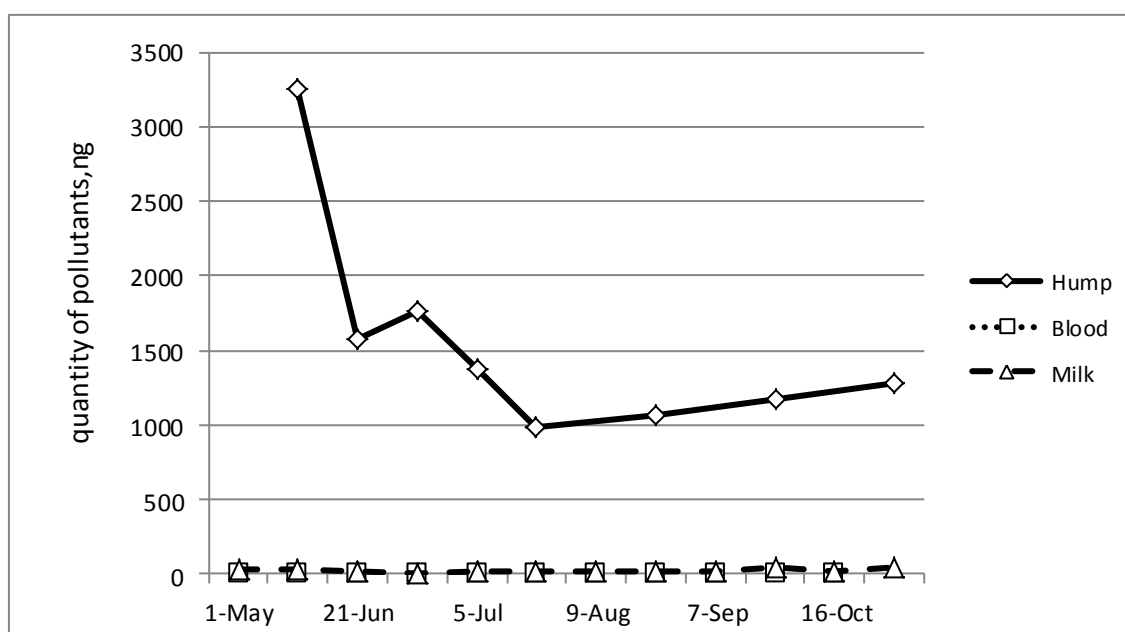


Figure 76-The amount of PCBs 52 in hump, blood and milk samples

The quantities of PCBs 52 in milk were between 7.66 ng/d and 59 ng/d. The maximum amount of this PCB congener in milk was 10 times less than minimum quantity of PCB 52 in hump (figure 76).

The quantities of PCB 52 in blood serum ranged from 6.58 ng to 29 ng. The quantities of PCB 52 in blood serum were 200 times less than concentration in hump. And this amount 2 times less than quantity in milk (figure 76).

The first reason of the presence of huge amount of pollutants in the hump is that the PCBs are highly lipophilic compounds. The lipid content of hump of dromedary camel ranged between 55% and 65%. [124]

The fat content of milk in experimental Bactrian camels ranged between 5.25 and 8.2 g/L. This fat content of Bactrian camel milk was closed that was shown in literature [125].

The organic contaminant concentrations level of pollutants in blood serum is low because blood serum included low lipid content and high concentrations of hydrophobic protein [126]. The lipid content of blood serum in Dromedary camel consists of 13 mg/L of cholesterol and 0.5 g/L triglycerides [127]. In other literature reference reported in male dromedary camel average cholesterol was 0.90 mmol/L, triglyceride 0.50 mmol/L and total lipid content ranged 319 – 5.07 g/L (table 25) [128].

Table 25- The comparative data of lipid content of hump, serum of blood and milk of our experimental Camels to the literature

	Lipid content of tissues	
	Experiment	Literature
Hump	-	55-65% (Bengoumi et al., 2005)
Milk	5.25-8.2%	2.9-5.5% (Khan et al., 2001) in <i>Bactrian Camel</i> 5.5 - 6.67 % (Konuspayeva et al., 2009) in <i>Bactrian Camel</i>
Serum of Blood	-	Total lipid in male Dromedary camel 3.19-5.07 g/L (Nazifi at al, 2000)

The assessment of the transfer ability of PCBs between the different samples (milk, serum and hump tissue) is reported in the annexes (appendixes 2.3.4). To assess the ability of PCB congeners to reach each tissue, the pollutants need to reach steady state conditions – the plateau. According to our experiment, the pollutants reached steady state concentration in samples at the end of the contamination period which lasted approximately in 8-9 weeks. This duration was slowly than milk of goats, which is between 8- 22 days [129].

If we compare each type of sample (milk, blood serum and hump tissue) almost 50% of determined PCB 28 were transported to the serum, 18% in milk and 23% was in hump tissue. Approximately same context was for PCB 52 where 26% were transported to serum, 16% transported to milk and 10 % transported to hump tissue (figure 75). For other heavier PCB congeners, the abilities of transport to serum were also low (5-6%), and for the heaviest one (PCB 180) 1% in serum (figure 77).

The blood is a circulation system where lipid part carries “organic pollutants” to other tissues. But, as known in literature [130], some congeners which were present in food, but which were either undetected or found at low levels in milk-fat and body fat, were present at appreciable levels in blood, indicating that relatively little metabolism had occurred to PCBs in the blood. It is mean that for PCBs 28 and 52 which were in higher quantities, the metabolization was higher in blood than in milk and hump fat.

In milk, the kinetic of transfer of PCB congeners was different than in serum, the PCBs in the middle group being transferred in higher proportion (PCBs 118 and 138).

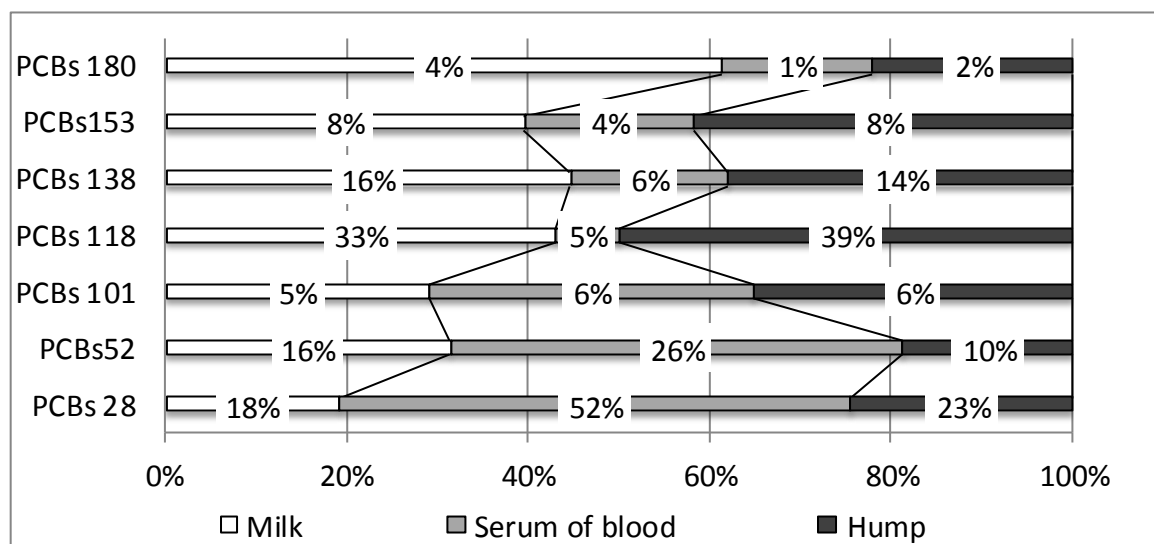


Figure 77-The ability of transition of PCB congeners

The light PCBs 28 and 52 are transferred at around 16-18% and the PCBs 101 and 180 at 4-5 %. The PCB 118 is transferred at 33%, when PCB 138 was at 16%. The PCB 153 was 8% of the determined concentration of pollutants (figure 78).

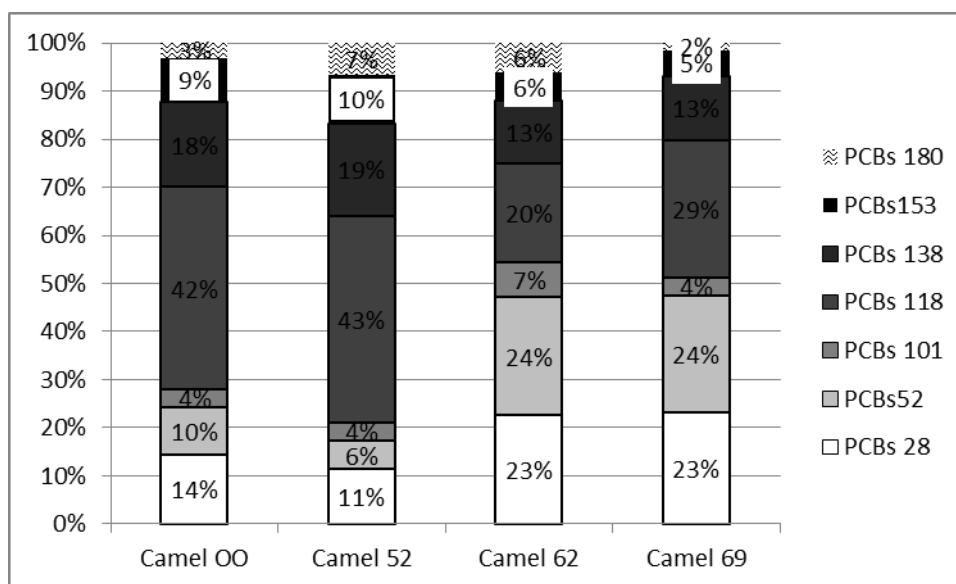


Figure 78-The distribution of PCBs in milk of experimental camels

In hump, transferred ability of PCBs was closed to the milk: heavy PCBs congeners (PCBs 118 and PCB 138) were more transferred (figure 79). This similarity between congener patterns of body fat and milk, was also reported for cattle [130, p. 1540]. It is probable that these congeners are relatively more metabolized in hump fat tissue and in milk fat.

When we observed the transition of pollutants on each camel in milk, the elder camels (15 years and more) had shown lower transposition for heavy PCBs

(PCBs 118, 138, 153 and 180). The younger camels (7 years old) have less transported lighter PCBs (PCBs 28, 52 and 101) than elders.

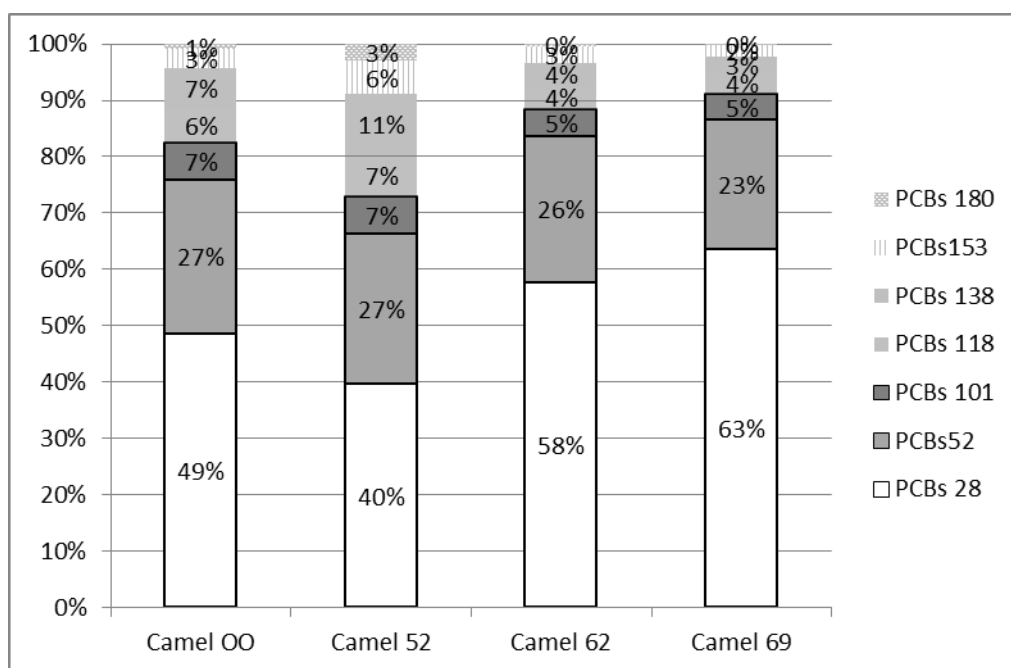


Figure 79- The distribution of PCBs in serum

The distribution of PCBs congeners seems similar in serum of blood for all camels. PCB 28 was between 40% and 63%. PCB 52 ranged from 23% to 27 %. And for other heavier PCBs, the distribution was similar (around 10 and less) (figure 80)

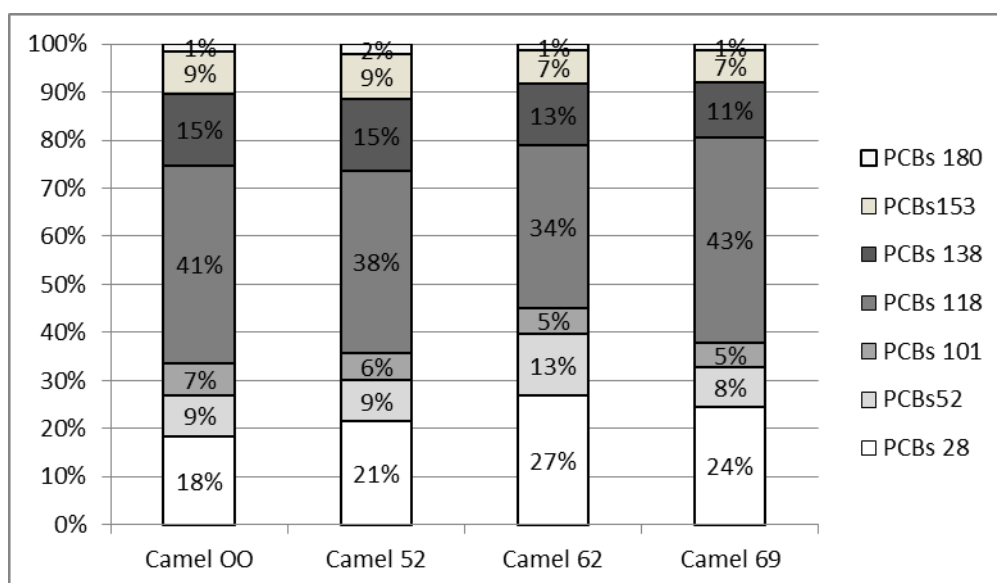


Figure 80- The distribution of PCBs in hump tissue

As described before, the distribution of PCBs in hump was similar to milk. To hump PCB 118 and PCB 28 were more transferred. It was between 9-13% for PCB

52, between 11-15% for PCB 138 and less than 9% for other PCBs (PCBs 153 and 180) (figure 81).

The intensity of this transfer appeared to be a function of physico-chemical properties (chlorination or logKow) and metabolic behaviors of the molecules.

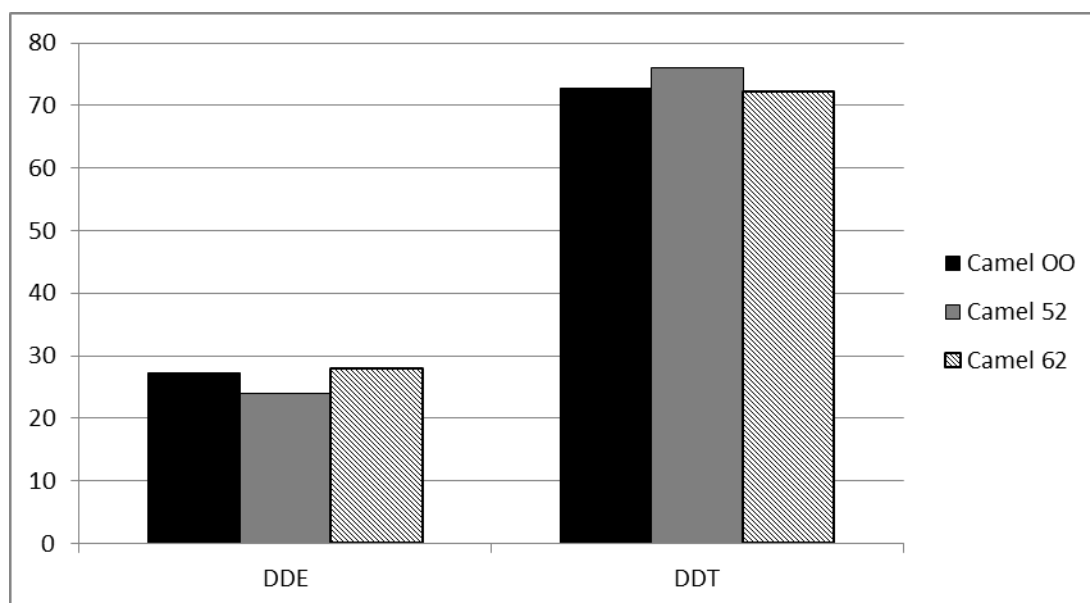


Figure 81-DDE and DDT distribution in milk

As described in figure 29, DDT was more excreted by milk than DDE for all camels. The logKow of DDE was 6.51 and DDT 6.91

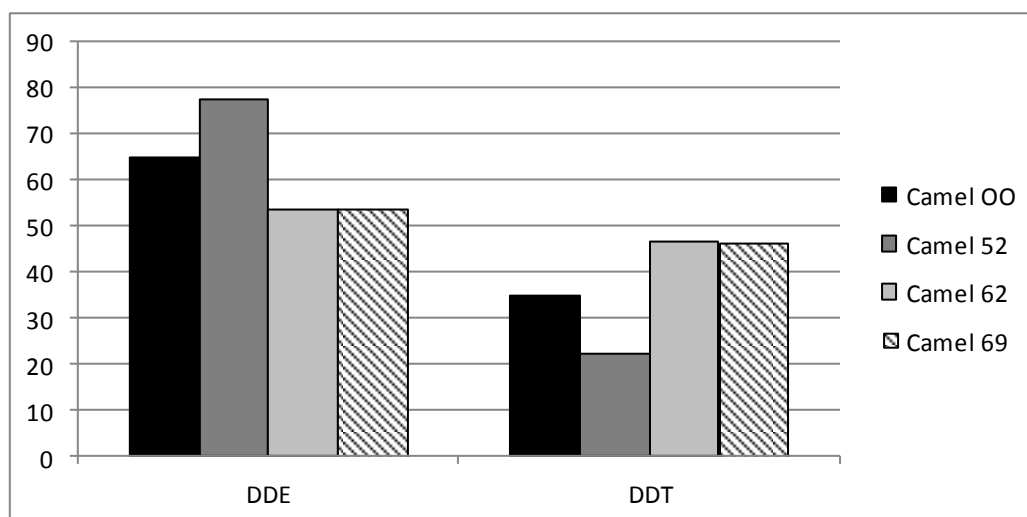


Figure 82-DDE and DDT distribution in blood serum

In milk, DDE was found in higher quantity than DDT in camel OO and 52. In camels 62 and 69 the distribution of DDE and DDT were approximately the same (figure 83).

The DDT was more transported to the hump than DDE, except camel OO, which was high in DDE and low in DDT.

DDT was more excreted by milk than DDE. It is mean that the DDT is not completely metabolized. When the excreted amount of DDT was 563 μg , the DDE excreted by milk was 5 times less (165 μg) during 176 days.

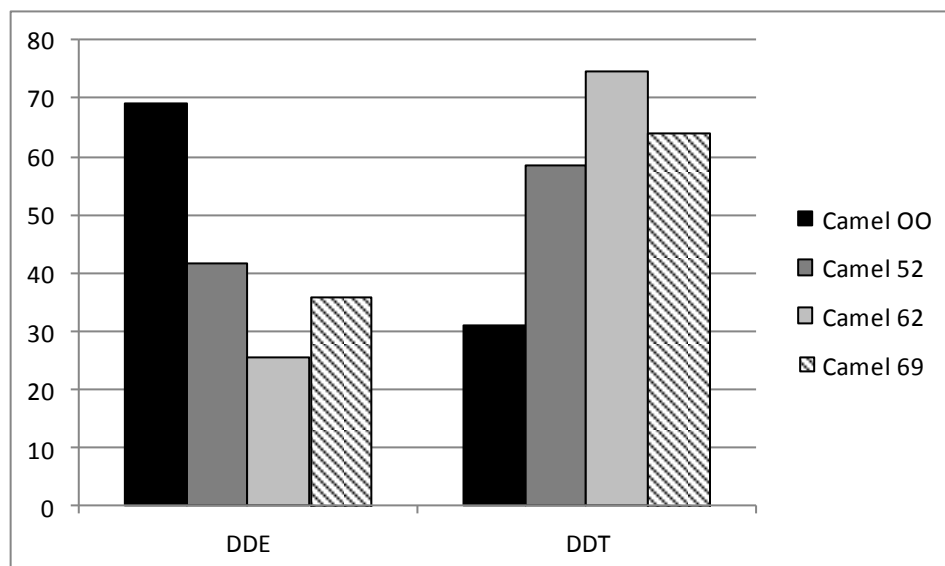


Figure 83- The distribution of DDT and DDE in hump

In last day of the sampling the stored amount of DDE was 77 μg and DDT, 87 μg (figure 84).

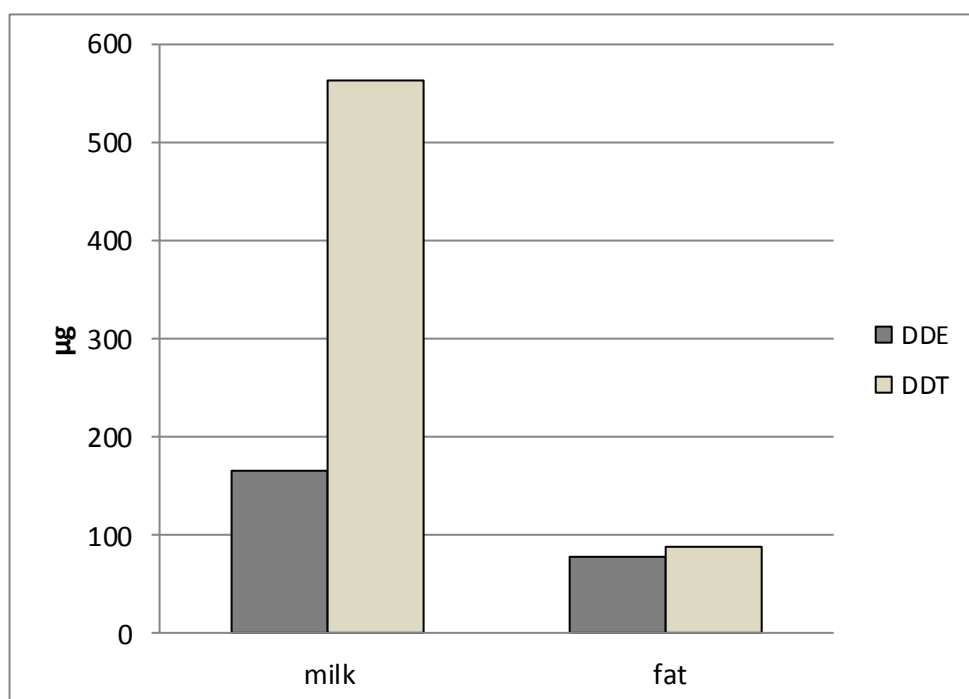


Figure 84-The comparative amount of DDT and DDE in excreted milk and stored hump

3.2.1 Bioaccumulation and decontamination mechanism of pollutants in different compartments

In the gastrointestinal tract, after ingestion of the capsule with contaminants, pollutants enter into forestomach of the camel, and then entered in the bloodstream. The blood transferred the pollutants to other compartments, especially in adipose tissue, the hump representing the main part. A part of the contaminants is excreted by milk in lactation ruminants (figure 85) and probably through the feces.

At the beginning of the contamination period, the lipophilic properties of pollutants lead to a rapid increasing of their concentrations in hump, and because the animals are in phase of fat storage, in total quantity. In the same time, the concentration in blood and milk did not increase. When the plateau is reached after two months of contamination, the concentrations in blood and milk increased, testifying of the elimination of pollutants.

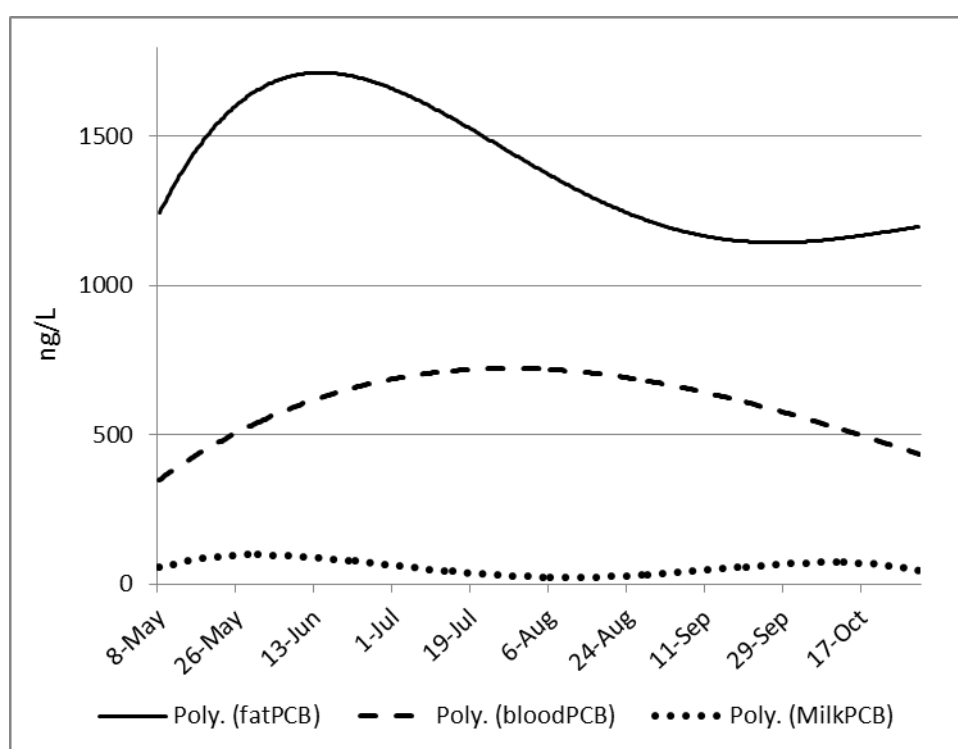


Figure 85 – The PCBs concentration in different compartment of the camel (hump fat, blood serum and milk) according polynomial model (order5) of the kinetic.

This phenomenon is accentuated because the hump weight decreased after starting decontamination (during summer time) due to the fat mobilization. The concentration and the quantity of pollutants stored in hump decreased regularly all along the decontamination period. The elimination in milk appeared low in quantity because the transfer to milk is in low percentage (between 2 and 9% according to congeners) contrary to other species as cow and goat. A similar trend occurred for PCBs and DDT (figures 85 and 86).

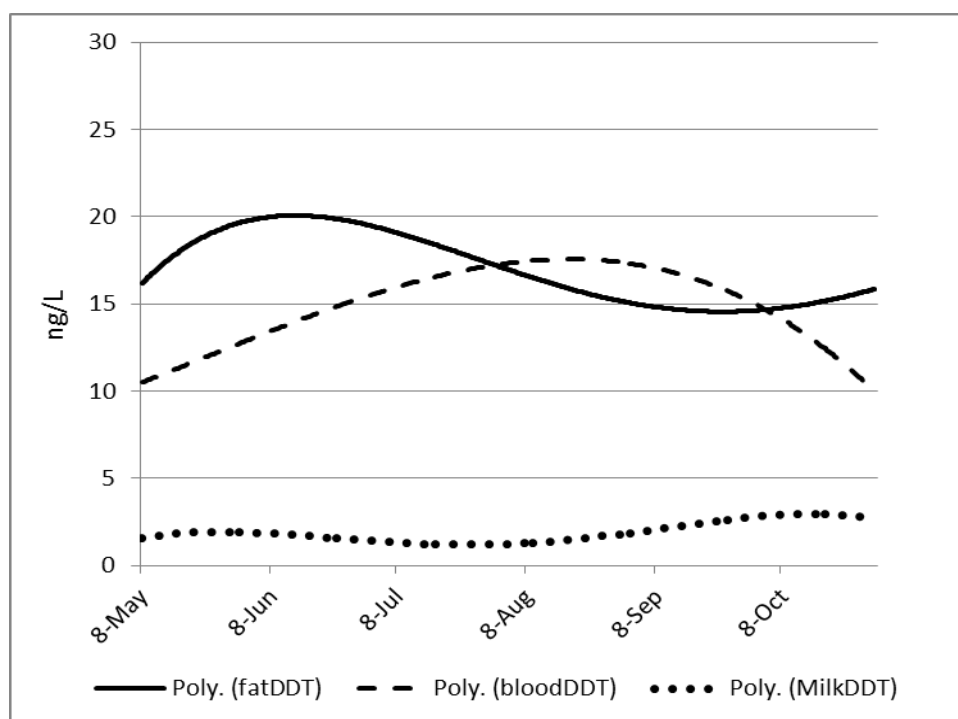
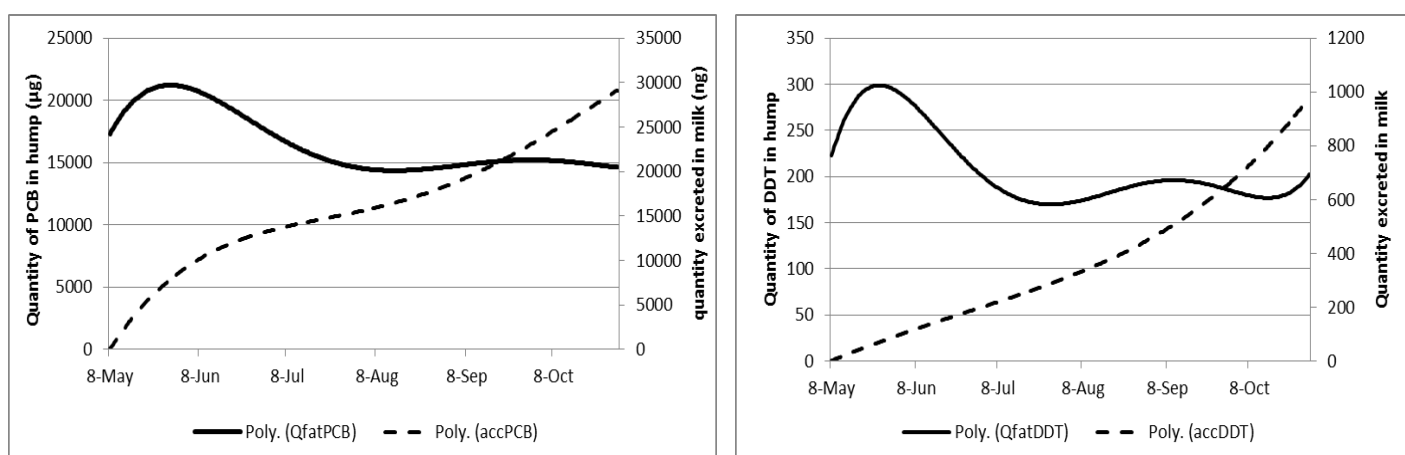


Figure 86 – The DDT/E concentration in different compartment of the camel (hump fat, blood serum and milk) according polynomial model (order5) of the kinetic.

By considering the cumulative excretion in milk all along the experiment and the quantity of pollutants in hump at the beginning of the experiment, the global kinetic of bioaccumulation and excretion process could be summarized for both PCB and DDT (figure 87).



Figures 87. Kinetic of bioaccumulation and decontamination in hump fat, and of cumulative milk excretion of PCB (left) and DDT (right) based on polynomial model (order 5).

At the end of experimentation, the total quantity of PCB and DDT excreted in milk were estimated to 28,6 and 0,95 µg respectively and the total quantity

accumulated during the contamination period in hump was 5530,4 and 54,3 µg respectively. In consequence, the percentage of excreted pollutants in milk was low: only 0.52% for PCB and 1.74% for DDT on average. The percentage of pollutants accumulated in hump was less than 15% of the total intake with a higher proportion for PCB than for DDT. After 4 months of decontamination, the total quantity of PCB and DDT disappearing was respectively 47,4% and 35,5% of the maximal concentration at the contamination period.

3.3. Limits and constraints of the present study

There is no, at our knowledge, an experimental farm with camels in Kazakhstan. It is why the trial has been achieved in a private farm in conditions which were not optimal. Elsewhere, the number of available camels was limited and due to the very high cost of the analyses, we had to limit the number of sampling and animals anyway. This limited number lead to a low statistical power of the experimental design.

For budget reason also, the analyses were not checked by international reference laboratory which are only available in Europe and in USA. As the quantity of POPs in the different measured matrices (fat, milk, serum) are in very low quantity (some nanogrammes) even in contaminated animals, the variability between animals could be very important.

However, the strict respect of the protocol during the experimentation, the care for achieving the analyses, and the assessment of the kinetic by using polynomial model with a high level of order could contribute to attenuate these constraints.

4 CONCLUSION

The main aim of the research work was to study the transfer of DDT and PCBs to the organism of the Bactrian Camels and the decontamination kinetics of these organic pollutants. Besides the assessment of the live weight, hump volume and milk yield in field conditions, the main conclusions of our work regarding the transfer of POPs in Bactrian camel model are the followings:

1. The role of the camel hump (from 5.3 to 21.5 kg) as a pivotal organ (due to its importance in the cycle lipid storage/lipid mobilization) in the metabolism of pollutants having lipophilic properties is confirmed.

2. At reverse, in spite of the importance route of excretion thanks to its fat component, only small amount of pollutants are observed in milk. On average, after 6 months of experiment, the percentage excreted in milk was 0.52% (PCBs) and 1.74% (DDT) of the cumulative POPs in the hump, but there is a high variability between congeners.

3. Based on the maximum quantity of pollutants in hump during the contamination period and the quantity available at the end of experiment, the percentage of loss of PCB was 47,4% and for DDT, it was 35,5%, that's mean the camel could be completely decontaminated within less than one year.

4. Moreover, based on literature data, the concentrations of pollutants in milk were low compared to other milk from contaminated dairy animals as goat and cow. For example, The carry-over rate (COR) was 8.9% for PCB52 in our study vs 25% in goat, and 7.7% for PCB180 in our study vs 55% in goat and 65% in cow.

5. As the carry over rate for camels seem very low, in comparison to other ruminants, we could conclude that:

- a. The camels would transfer pollutants in milk less than other ruminants;
- b. There is probably an overestimation of exposure in our experimental camels.

6. The concentrations of pollutants in blood are not sufficient indicator of the contamination status of the camels, the right interpretation needing to have also sampling of storage organs and of excretion ways.

Regarding technical, scientific and practical approaches for the present research work, following conclusions could be done:

- *Technically*: There was insufficient sensitivity of analysis for the heavy PCB (118, 138,153,180). In consequence, samples have to be checked in reference laboratory;
- *Scientifically*: the Bactrian camel can be regarded as interesting biological model, because the presence of important concentration of fat storage in humps.
- *Practically*: the analytical results can be useful for estimating the risk of exposure of consumers (milk and meat). They could contribute also to the establishment of standards, especially to valorize animal products in polluted areas and protect, in the same time, the consumers.

However, regarding the risk for consumers in polluted areas, it may recommend to avoid the consumption of fresh fat from camel hump as it is practiced traditionnaly. At reverse, the risk of contamination by the milk appears lower than for other dairy animals.

The present work has been achieved in a private farm. The lack of experimental camel farm in Research structures of Kazakhstan is an important constraint for the future research activities regarding this species.

In the international scientific community interested by the camel (International Society for Camelid Research and Development –ISOCARD), the studies regarding the behavior of camel face to the pollution are very few. The present study appears original and innovative for camel scientists over the world and confirms the interest of this species as biological model in such research regarding the impact of environmental pollution on animal products.

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APPENDIXES

Appendix A- The table of Chashkin

	100	103	106	109	112	115	118	121	124	127	130	133	137	139	142	145	148	151	154	157	160	163	166	172	175	178	179	180
146	158	163	168																									
148	169	174	178	184																								
154	180	184	189	194	203	207																						
158	190	195	200	204	209	213	218	223	229	235																		
162	201	206	210	215	220	225	231	237	243	249	257	266																
166	211	217	221	227	233	239	245	251	257	264	273	282	290															
170	222	228	234	240	246	252	258	264	270	278	287	296	305	314														
174			246	252	258	264	270	276	282	290	299	309	319	328	376													
178				266	272	278	284	290	296	305	314	323	332	341	350													
182					286	292	298	304	310	319	328	337	346	355	365	374												
186							313	319	325	334	343	353	361	370	381	390												
190								335	341	350	359	368	377	387	397	406	416											
194									357	366	375	384	393	401	413	422	433	442										
198										382	392	401	410	419	430	439	449	458	459									
202											408	417	427	436	446	455	464	473	484	498								
206												433	442	451	462	471	480	489	500	512	527	541						
210													458	467	478	486	495	504	515	529	542	556	571					
214														483	494	502	510	519	531	544	557	571	586	601	616			
218														499	510	518	526	535	547	560	573	587	602	617	632	646	659	664
222															525	531	540	548	560	575	589	603	618	632	645	659	672	677
226															538	544	553	561	573	588	603	617	632	645	658	672	685	690
230															552	558	566	574	586	600	615	629	645	658	671	685	698	703
234																572	579	587	599	614	627	642	658	671	684	698	711	716
238																	593	600	612	626	641	656	671	684	697	711	724	729
242																		614	626	640	655	669	684	697	710	724	737	742
246																			641	654	668	682	697	710	723	737	750	755
250																				670	683	695	710	723	736	750	763	768
254																				683	697	708	723	736	749	763	776	781
258																					709	721	736	749	762	776	789	794
262																						734	749	762	775	789	802	805
266																						747	761	775	788	802	815	820
270																							770	788	802	815	829	833

Appendix B - The profiles of PCB congeners in plateau of serum of blood
 Figure B-1
 The profiles of PCB congeners in plateau of serum of blood of camel OO

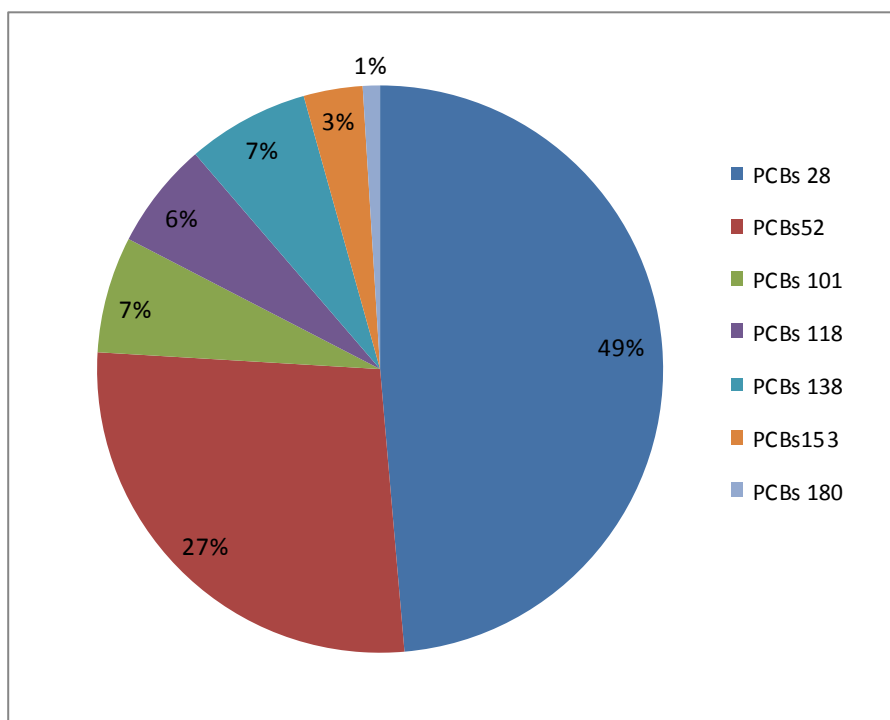


Figure B - 2
 The profiles of PCB congeners in plateau of serum of blood of Came 52

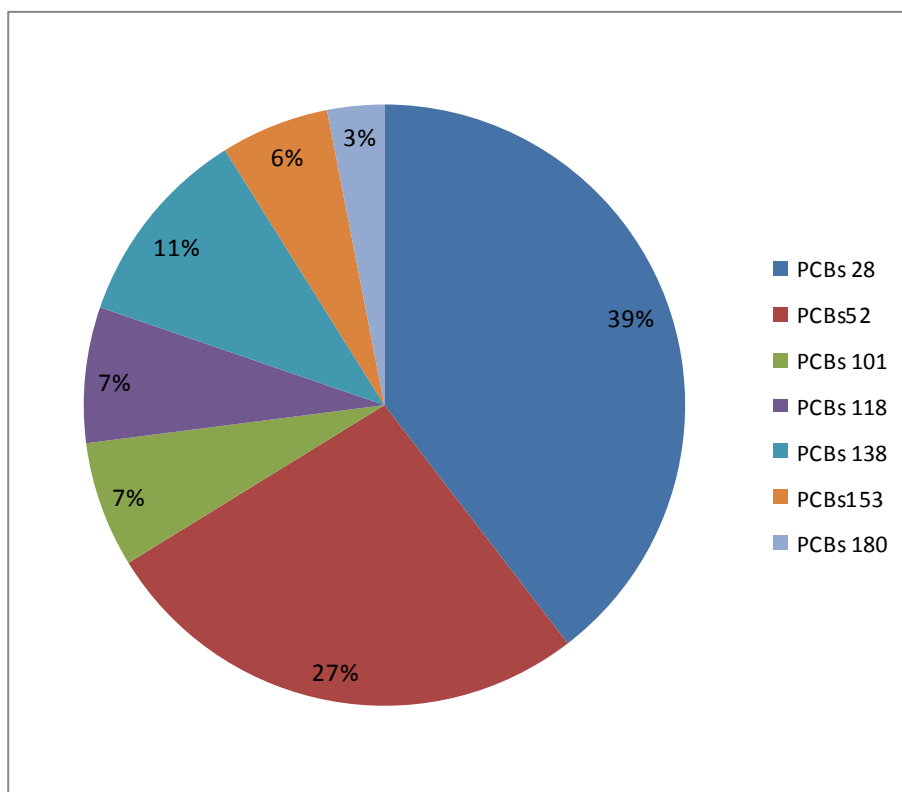


Figure B – 3 - The profiles of PCB congeners in plateau of serum of blood of Came 62

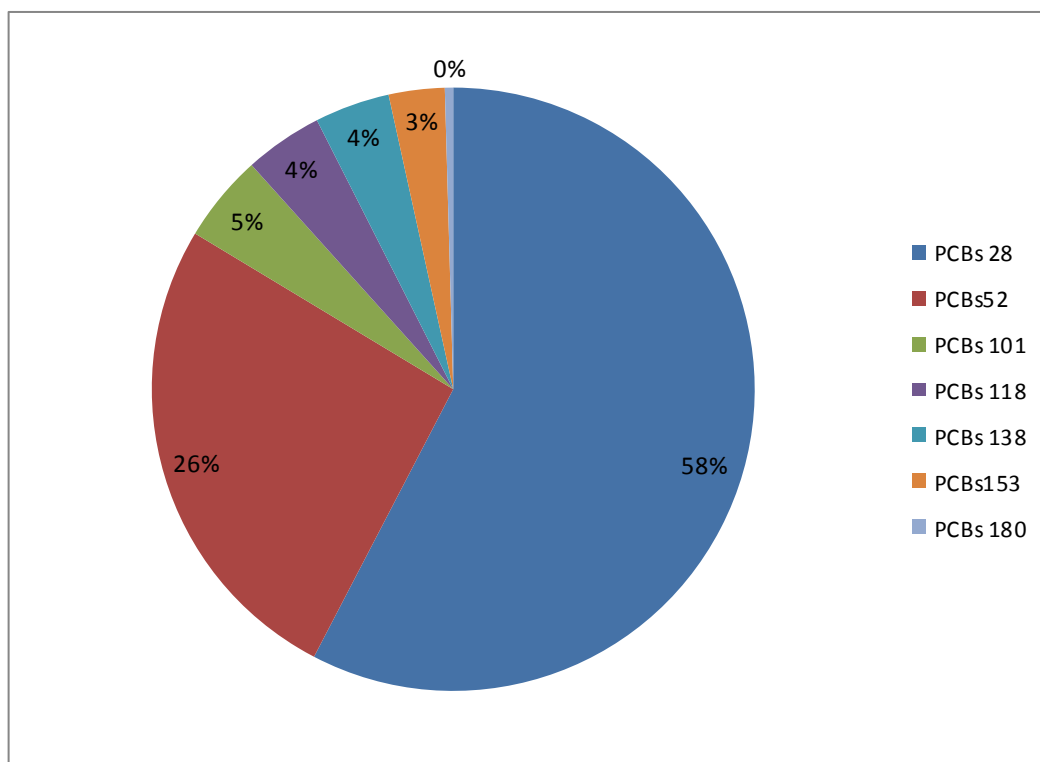
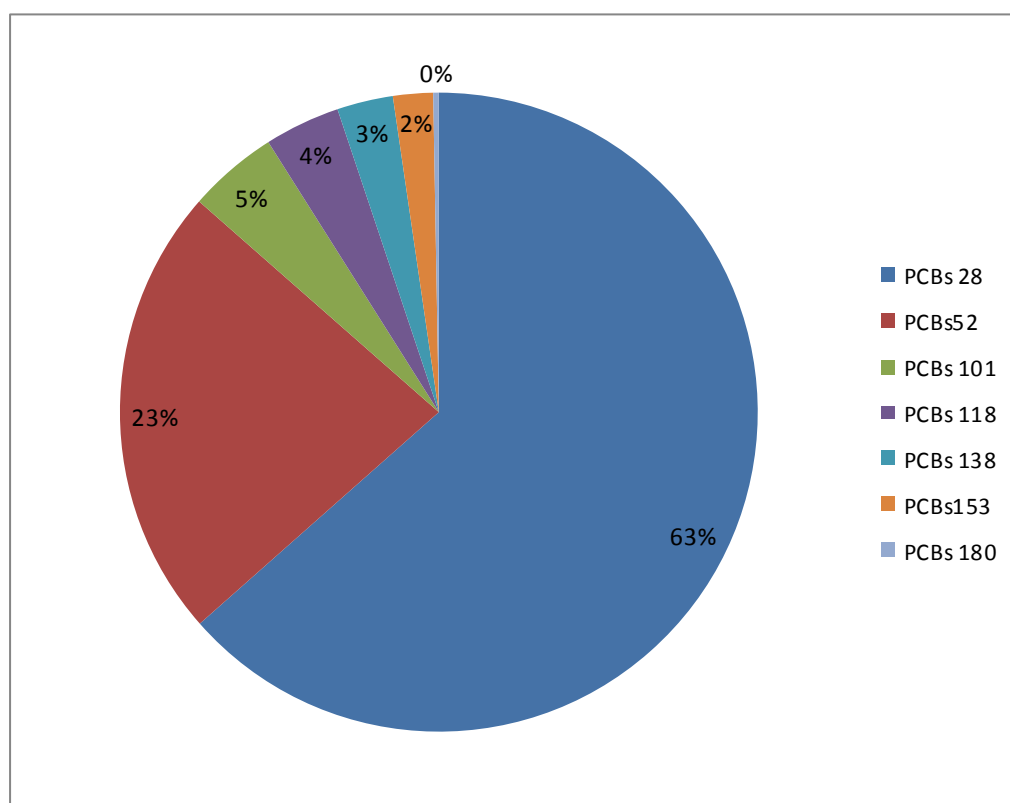


Figure B – 4 - The profiles of PCB congeners in plateau of serum of blood of Came 69



Appendix C-The profiles of PCB congeners in plateau of milk

Figure C-1- The profiles of PCB congeners in plateau of milk of camel OO

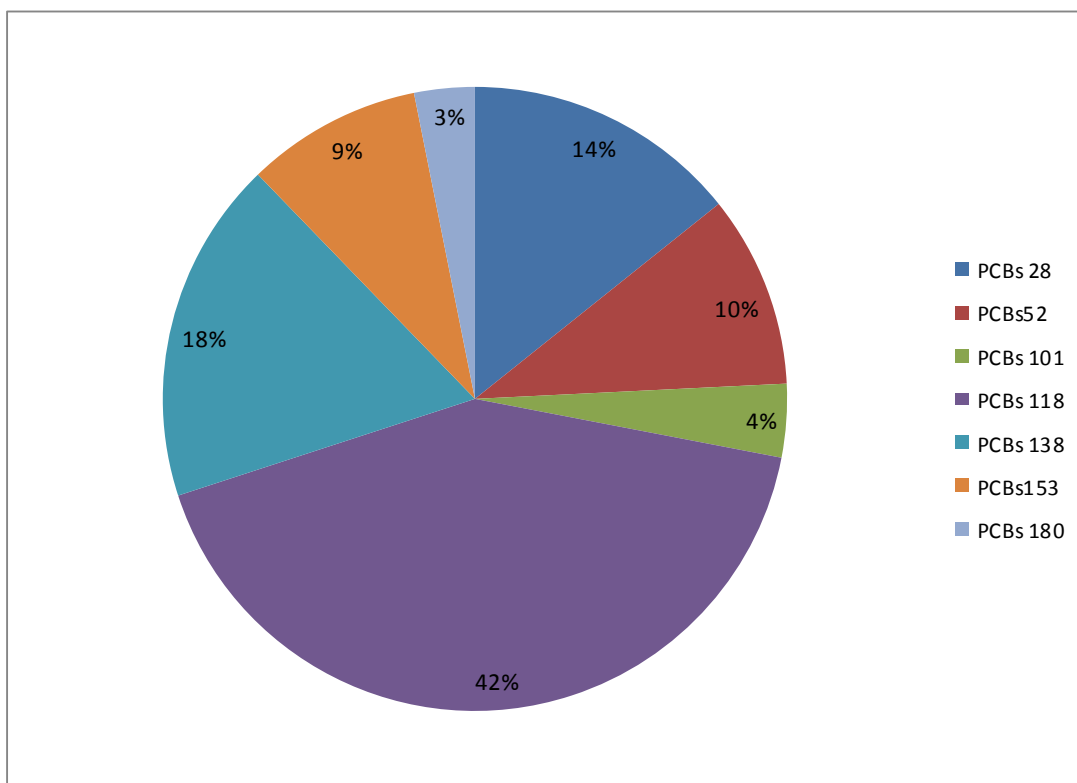


Figure C-2- The profiles of PCB congeners in plateau of milk of camel 52

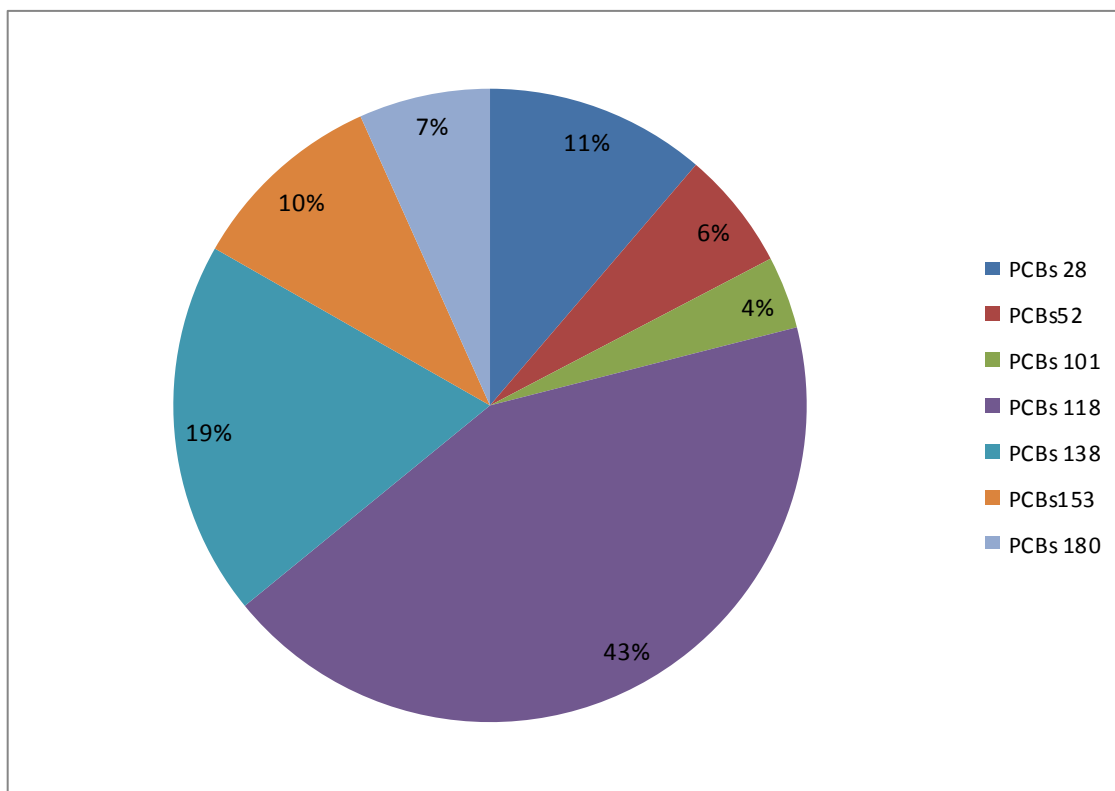


Figure C-3- The profiles of PCB congeners in plateau of milk of camel 62

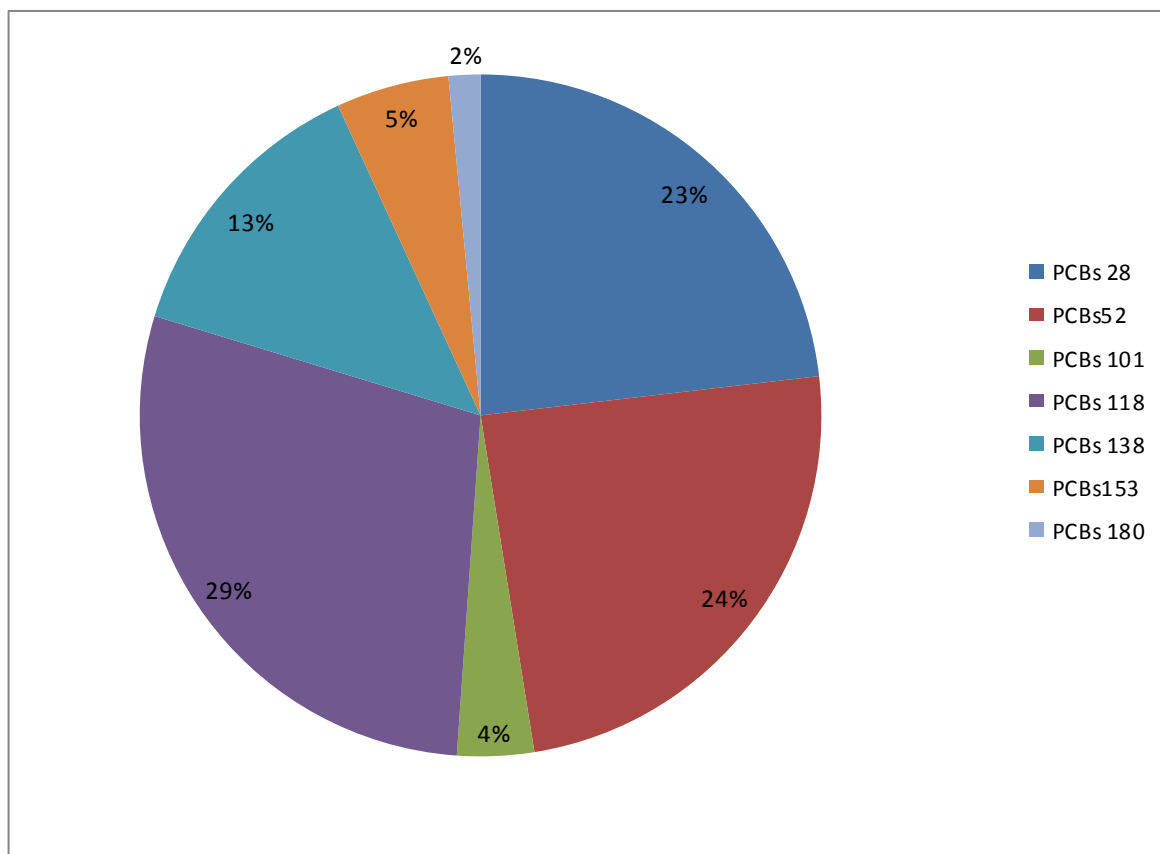
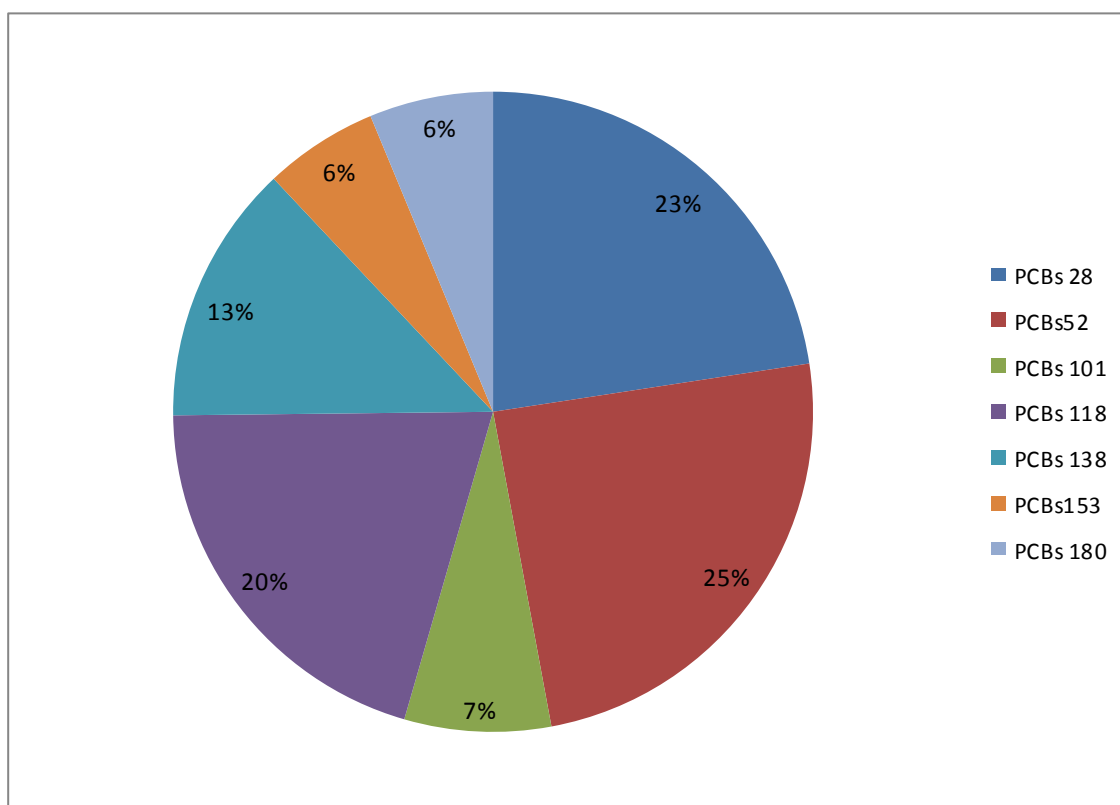


Figure C-4- The profiles of PCB congeners in plateau of milk of camel 69



Appendix D -The profiles of PCB congeners in plateau in hump fat tissue

Figure D- 1 The profiles of PCB congeners in plateau in hump fat tissue of camel OO

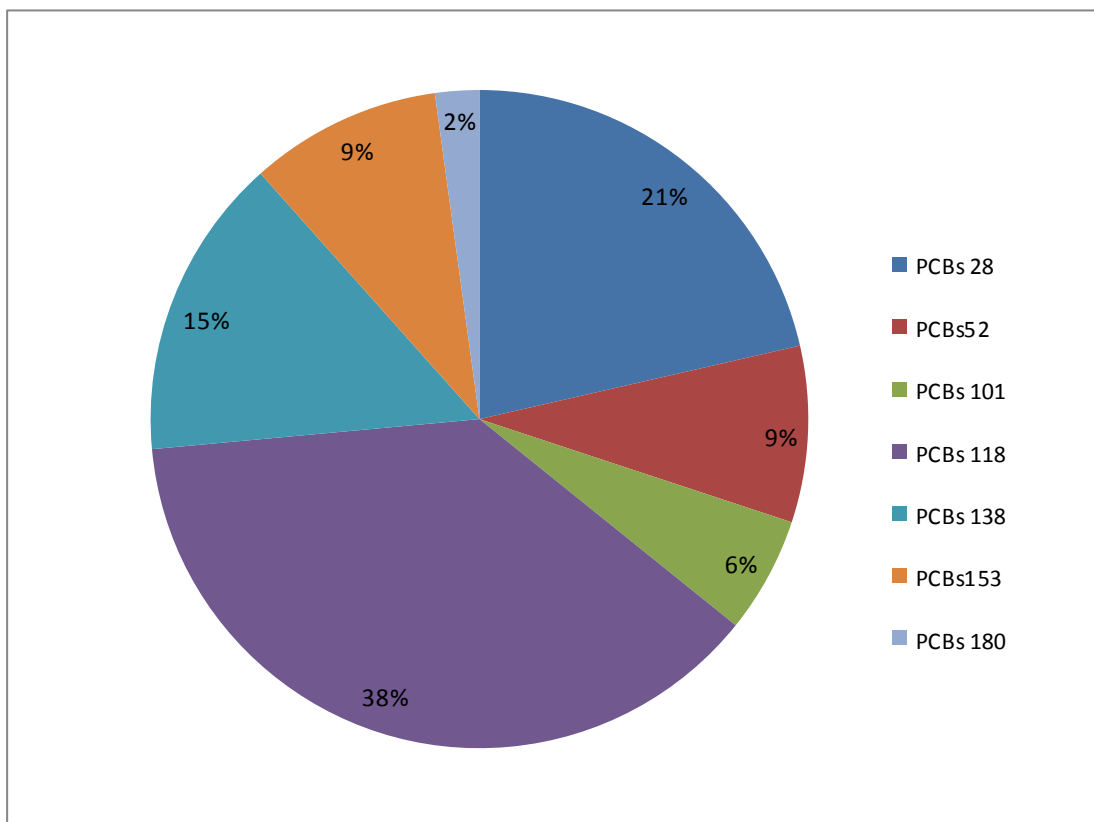


Figure D- 2 The profiles of PCB congeners in plateau in hump fat tissue of camel 52

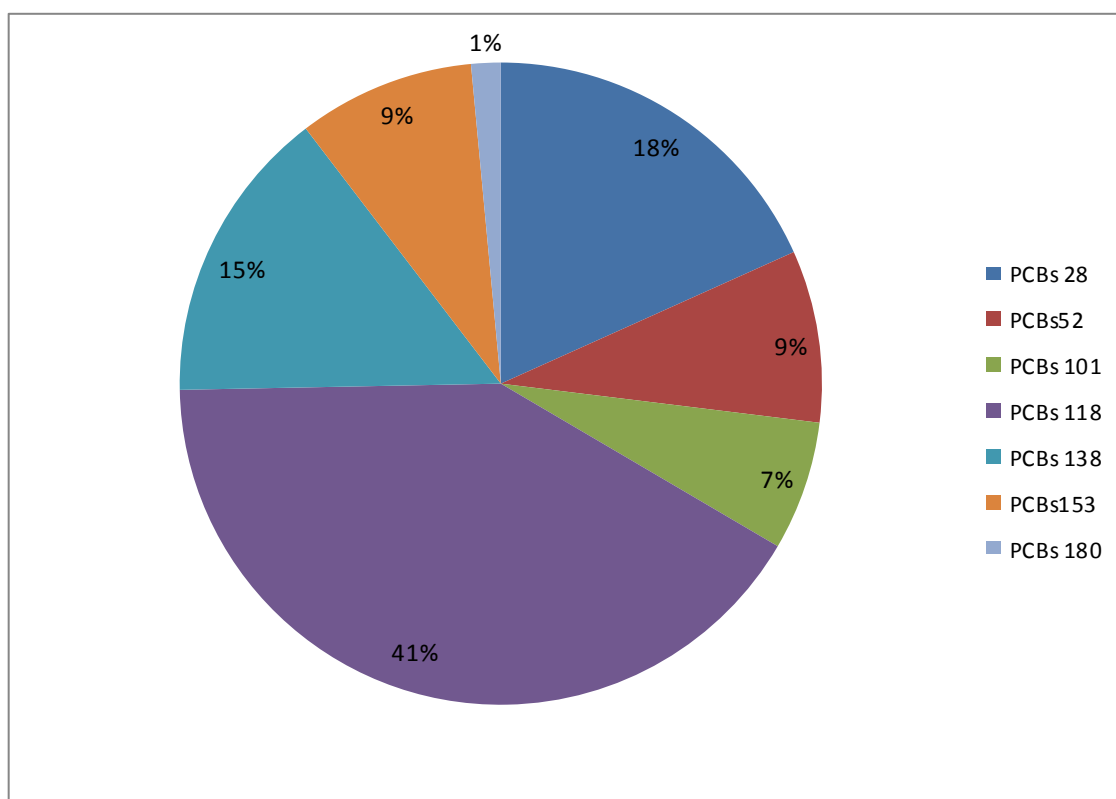


Figure D- 3 The profiles of PCB congeners in plateau in hump fat tissue of camel 62

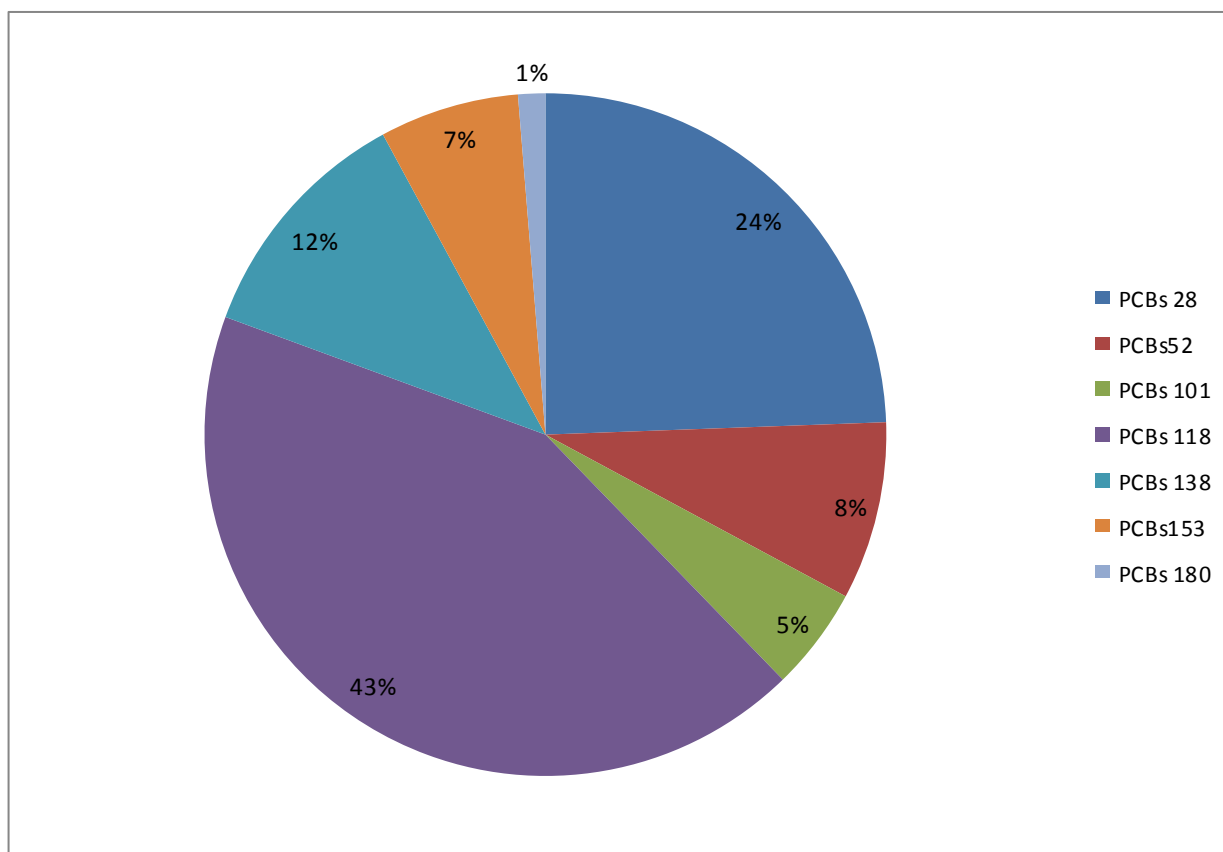
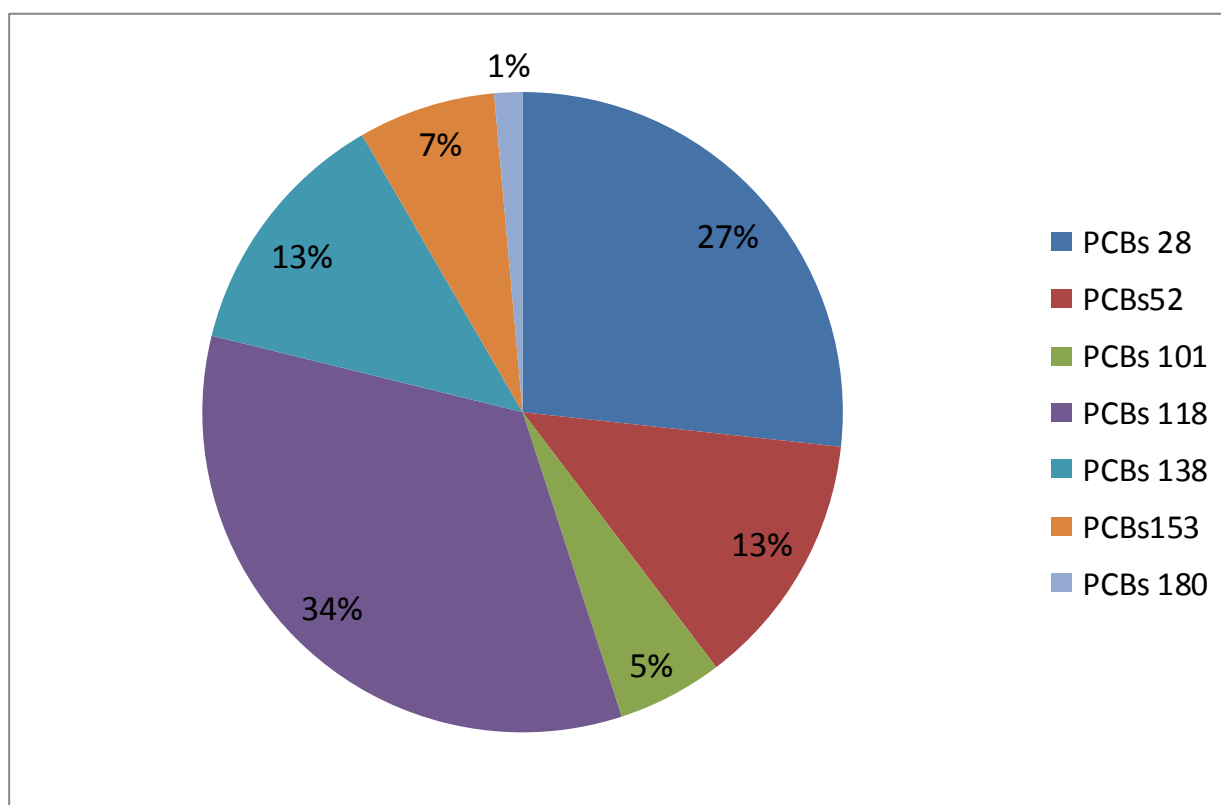
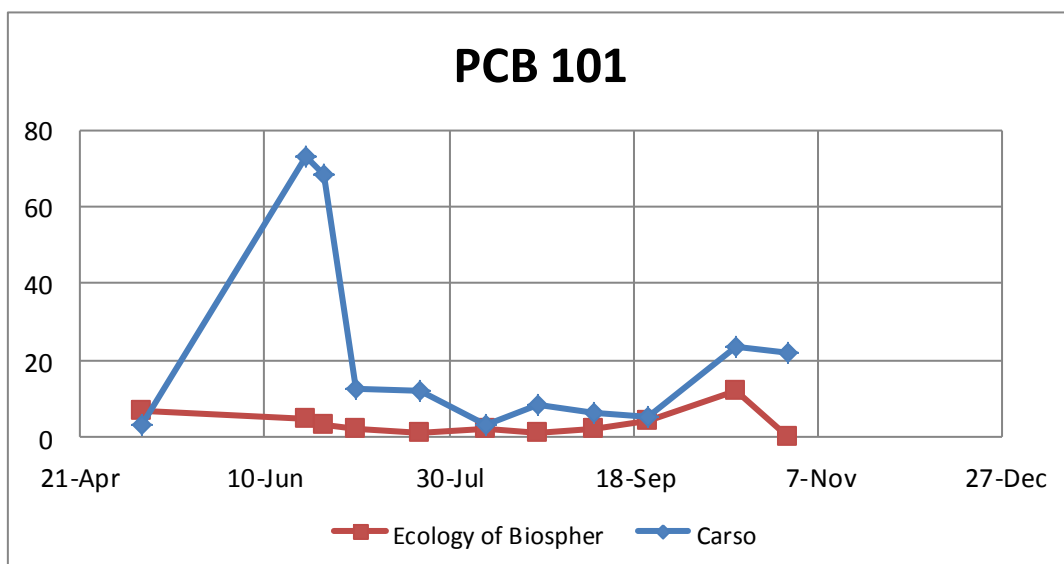
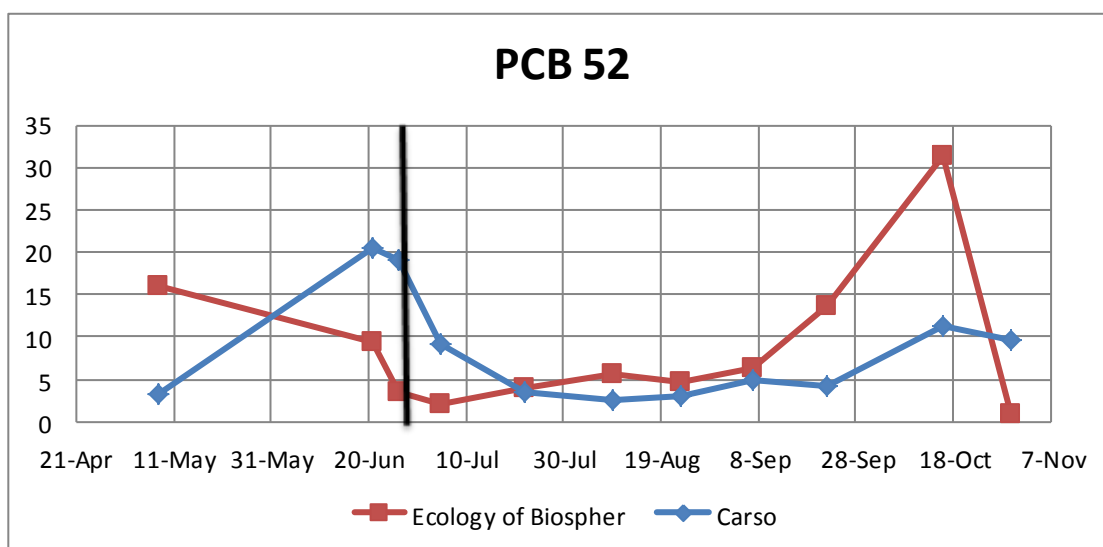
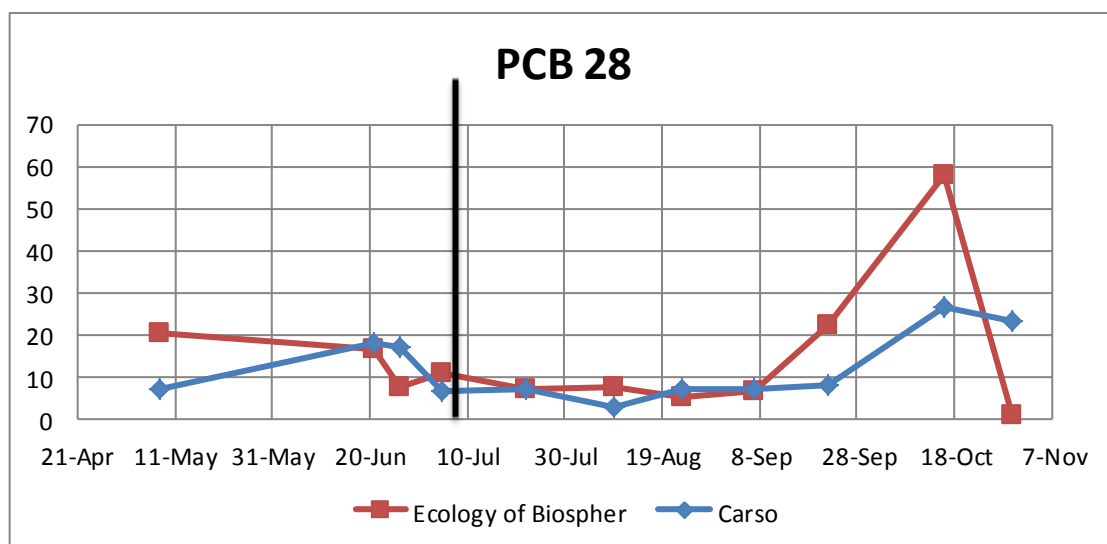
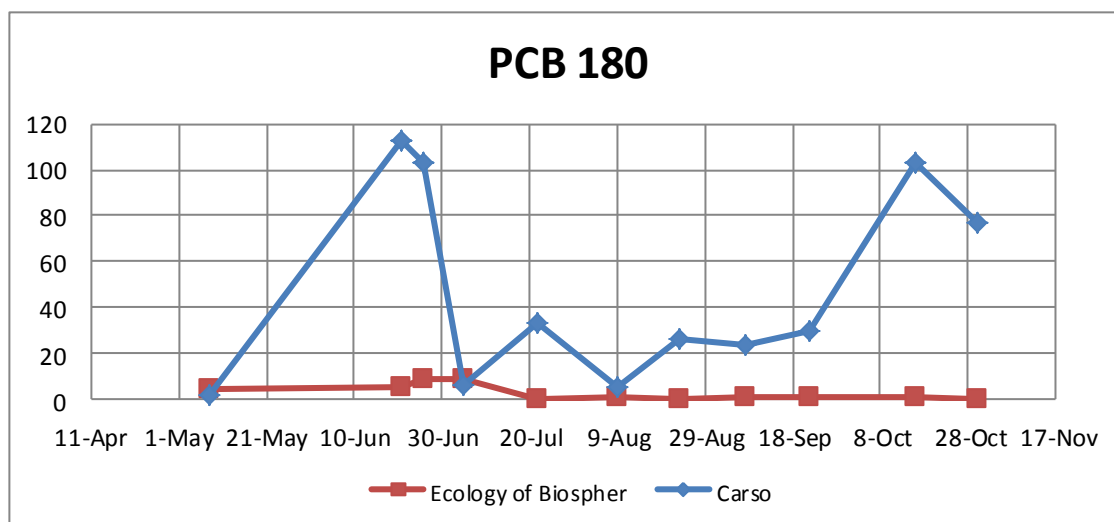
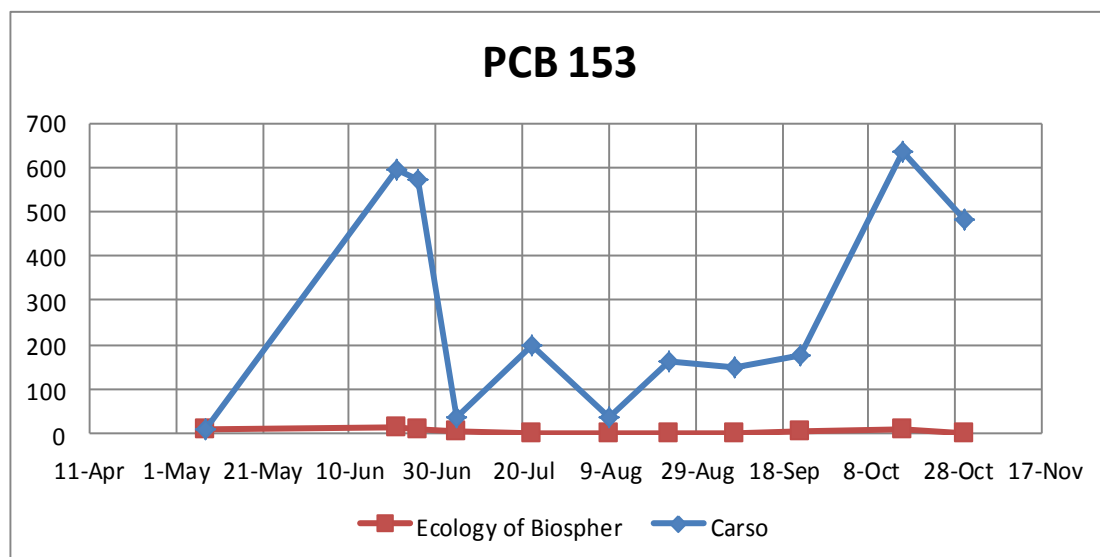
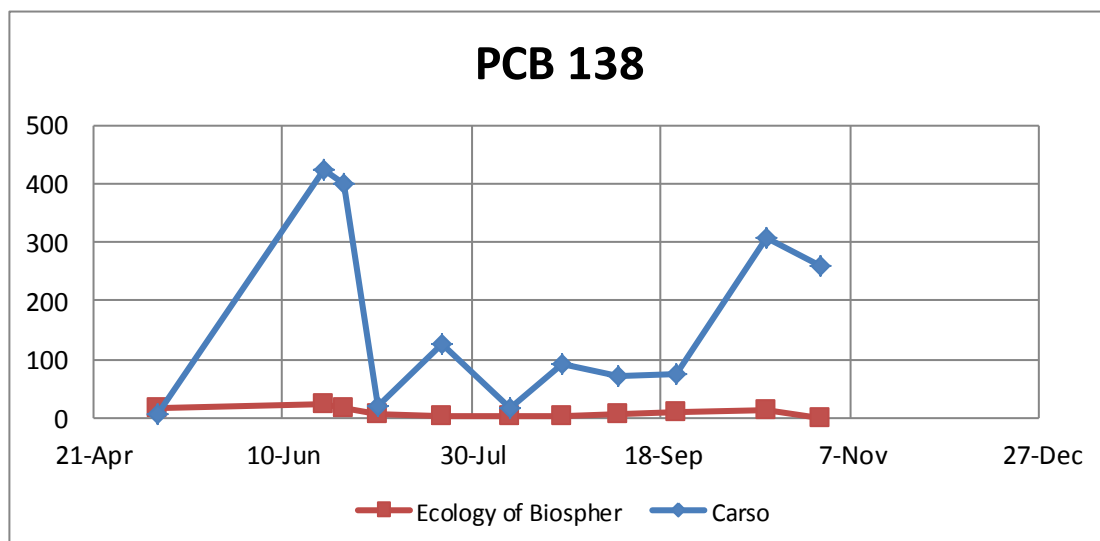


Figure D- 4 The profiles of PCB congeners in plateau in hump fat tissue of camel 69



Appendix F. The comparative results of milk analyzing of camel 52 between laboratory CARSO and CPHMA





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